Electrical West

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By Geo. P. Low.

HIGH in the rugged Sierras, up far beyond the reach of any but the most adventurous and where great fields of everlasting snow strikingly relieve the bleakness of the mountain fastness are the Blue Lakes—the brilliant gems of Alpine County that look out in sapphire from their settings of sombre distance. The rivulets that have nourished them into veritable inland seas ever continue to sustain them in pristine purity and how indispensible they are to perfect the grandeur of the scene is suggested in the above photographic engraving.

This and some of the illustrations which follow show the nature of the catchment area forming the source of the water supply of the Blue Lakes Water Company. Including, as it does, the entire Western Slope of the Sierra Nevadas embraced in Alpine, Amador and Calaveras Counties, in California, and being of granitic formation, sparsely wooded and limited in soil and vegetation, and not only beyond the possibility of agricultural and manufacturing operation but also far above the mineral belt so as to preclude possibility of contamination from mining, it must forever furnish a pure and abundant supply of water. The snow varies in depth from five to twenty feet and in some portions of the watershed it never disappears, while the catchment area abounds in copious springs and streams that are never failing.

Of such are the headwaters of the stream whence is derived power for the operation of the electrical transmission plant of the Blue Lakes Water Company.

Part 1

THE WATER SUPPLY.

The Blue Lakes, so picturesquely situated as shown near the summit of the Sierra Nevada Mountains, together with auxiliary reservoirs, both in Alpine and Amador Counties, discharging into the tributaries of the North Fork of the Mokelumne River, are the chief sources of this water supply. These sources, owned and controlled by the company, consist of (1), the Upper or

West Blue Lake, which is a deep mountain lake of fresh pure water, situated at an elevation of 8,109 feet above sea level, and which, in its original condition, comprised 230 acres, but in 1887 there was finished across its outlet a solid masonry dam, having a length of 250 feet on top, a width of 50 feet on

FROM THIS SUMMIT THE INITIAL ILLUSTRATION WAS PHOTOGRAPHED.

top and an extreme height of 25 feet, which increased the flooded area to 375 acres.

(2) Lower Blue Lake is two miles south of Upper Blue Lake and the latter empties into it through a stream having a fall of about ninety feet. Its area is about 160 acres, its elevation is 8,012 feet and it is confined by a dam of crib work with earth filling, having a

THERE'S TROUT-FISHING BETWEEN THESE ROCKS.

crest of 750 feet, a bottom width of 50 feet, a top width of 40 feet and an extreme height of 30 feet.

The catchment area drained by these two Blue Lakes is, by actual survey, 3050 acres and the surplus water from it, after filling the lakes, is discharged into Blue Creek and flows through Clover Valley to its junction with Deer Creek, thence into the North Fork of Mokelumne River and down its steep rocky bed for a distance of 40 miles, where the water is diverted into the Amador Canal at an elevation of 2,240 feet.

Supplemental sources of water supply and the reservoirs of the system consists of, (3) the Twin Lakes, united into a single body of water by a dam at their outlet on the northwesterly side. These are but one-half mile in a westerly direction from the Lower Blue Lake dam, and their area when full is 160 acres with a water shed of 900 acres. The dam is a short and solid structure, founded on granite and is made with front and back retaining walls of dry masonry with earth filling. It is of sufficient dimensions to raise the surface of these lakes 20 feet vertically. The water is discharged from Twin Lakes into a stream which flows down to Lake Valley or Meadow Lake, thence into the North Fork of the Mokelumne River.

(4.) Meadow Lake, or Lake Valley, is an artificial reservoir about three miles westerly from Twin Lakes

A CHARACTERISTIC VIEW OF THE CATCHMENT AREA.

and nearly 450 feet below them in elevation. It was formed by throwing a 450-foot dam across the westerly end of an immense granite basin, otherwise completely surrounded by mountains of great height, forming a portion of the route of Meadow Creek, which is a tributary of the North Fork of the Mokelumne River. The drainage area of Meadow Lake comprises over two thou-

GRANITE LAKE.

sand acres and floods about 150 acres with the present 25-foot dam.

(5.) Bear River reservior was formed by the building of a dam of heavy masonry with a cemented rubble core across the Bear River, which is a tributary of the North Fork of the Mokelumne River. This dam is curved up

stream in the form of an arch and abuts against the granite walls of the canyon. Its altitude is 5,670 feet and its drainage area is over twelve square miles.

The above list of lakes and reservoirs includes those now improved and which form a part of the system of

TWIN LAKES.

water supply of the Blue Lakes Water Company. In addition to these storage reservoirs, further reservoir sites and water rights have been located and appropriated for future use when the demands of the company shall require additional storage facilities, and among these are the Deer Valley site, which is three miles below the dam of Lower Blue Lake, the Grouse Valley site, the Snow Valley site, Granite Lake, Bear River, Lower Bear River, and Cold Creek. Concerning these reservoir sites it is interesting to note that the waste waters from the two Blue Lakes and also the flow from Indian Creek, and a number of small lakes in Indian Valley pass through the site of Deer Valley reservoir. At the southeasterly end of the valley, granite bluffs approach to within a short distance from each other on either side of the stream and afford excellent abutments for a high masonry dam. With a dam 100 feet in height the proposed Deer Valley resevoir would impound nearly three thousand million gallons. The remaining reservoir sites are equally fortunate as to locations, and in each of them excellent building materials are on the ground or close at hand.

Various data concerning the principal Alpine reservoirs are presented in the accompanying table on page 5.

The reservoirs now in operation, together with the reservoir sites located by the Blue Lakes Water Company are situated on tributaries on the North Fork of the Mokelumne River. The lakes and reservoirs are held in reserve and are drawn upon only during the four months each year constituting the dry season. After that period and until the summer months of the following year, the melting snow and the prevailing rains flood the streams and tributaries of the North Fork of the Mokelumne River, furnishing a supply at the head of the Amador Canal, which is greatly in excess of all possible demands. The bed of the Mokelumne river is practically of solid granite throughout almost the entire portion used as water-way for supplying the Amador Canal. The Mokelumne River Canyon is deep and precipitous, and being of granite formation there is practically no loss of water from seepage and but little loss from evaporation from the lakes to the headgates of the Amador Canal.

Part ii

THE CANAL SYSTEM.

Strictly speaking the canal supplying water for the operation of the Blue Lakes system originates as above stated, in Blue Creek, forming the outlet of Blue Lakes, whence it flows through Clover Valley into Deer Creek, thence into the North Fork of the Mokelumne River, along which it runs for a distance of forty miles to the point where the water is diverted into the Amador Canal. For this distance, therefore, the water follows a natural course and during the dry season of the year the only water which comes down the Mokelumne River is that which is allowed to run into it from the reservoirs of

LOWER BLUE LAKE.

the Blue Lakes system. The Amador canal is 42½ miles in length, nearly one-half of which lies along the steep rocky slopes of the main canyon of the Mokelumne River. Eighteen miles below the head gate the canal turns abruptly to the north, passing through a short tunnel and emerging upon the other side of a divide where it enters

into a country of very different character. As the canal has a southerly exposure along the river side, such snow as falls quickly melts and the canal is never blocked with snow or ice. Eight miles below the head gates the canal passes around a bare granite cliff known as Bald Rock, in a wooden flume one mile in length. From the head works to the foot of Bald Rock, the general character of the country is granitic; between Bald Rock and the tunnel it passes through a formation of slate, while below the tunnel to the end of the canal the earth is of clay and gravel, forming an excellent ground for ditching purposes. Beyond the tunnel the canal winds around the slopes and head branches of the valley of Jackson Creek at a height of 400 to 500 feet above the level of Jackson until it reaches Summit Ridge, between Sutter and Jackson Creeks, along which it passes to Tanner Reservoir, near the town of Sutter Creek.

Amador canal forms the main artery of the system of the Blue Lakes Water Company and its present capacity is about 3,000 miners inches of water. Along its course are 82 flumes aggregating 3.7 miles in length, but many of these flumes are very short and can be economically filled. Its grade or fall is eight feet per mile, causing an average velocity of flow of 300 feet per minute and in addition to supplying water for the company's electric power plant and operating a number of mines, it furnishes water to distributing reservoirs supplying the towns of Jackson and Sutter Creek, Amador City, Ione and other villages.

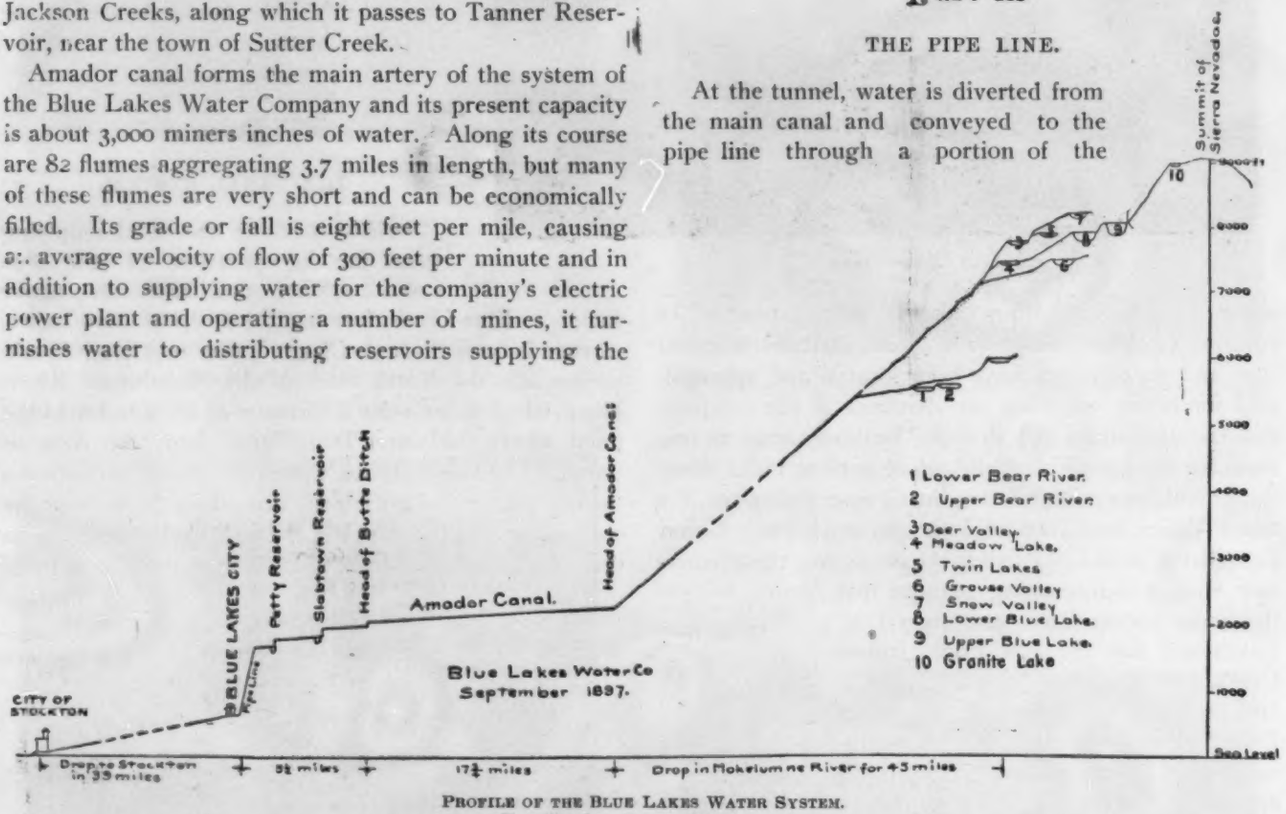
The subsidiary distributing ditches of the system consist of the Amador ditch, seven miles in length, supplying the towns of Amador and Sutter and several mines near by; the Ione ditch, sixteen miles in length and built by placer miners prior to 1859, supplying Ione City and various consumers along its line; the Kennedy ditch, supplying the Kennedy reservoir from the Tanner reservoir; the Moore ditch, nine miles in length, taking up the water discharged from the power wheels of the Kennedy mine and supplying it to the town of Jackson and to the Zeila and other mines and for irrigation purposes; the Montcherichard, Buena Vista, Newton, St. Mary's and Plymouth ditches, built for quartz and placer mining purposes, but which are no longer used; the Donnelly ditch, supplying water from the power wheels of the South Eureka hoist to the Donnelly reservoir, and lastly the Butte ditch, which was built by the miners of Butte City in 1855 at a cost of $75,000. For eighteen miles Butte ditch parallels the Amador canal and being immediately below the latter, the ditch is not now used for this distance. Below the tunnel of the Amador Canal, however, the ditches take different directions and the Butte ditch, with its ramifications, was for many years used as a distributing ditch for the Amador Canal, but the Butte ditch is now used for supplying water to the reservoir whence is derived the power for the operation of the Blue Lakes electric plant.

Part iii

THE PIPE LINE.

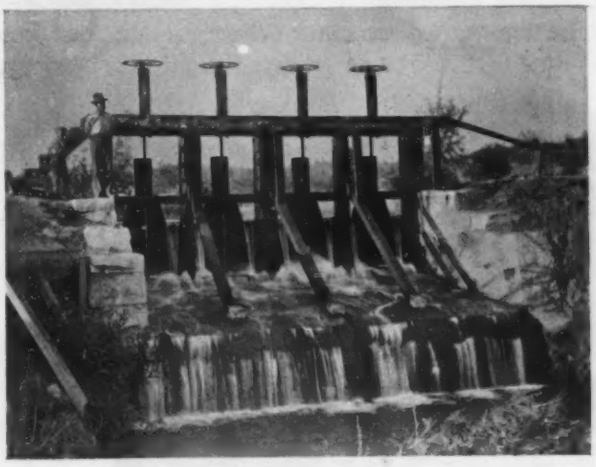
At the tunnel, water is diverted from the main canal and conveyed to the pipe line through a portion of the old Butte ditch, but much of its route has been changed and the ditch has been rebuilt and enlarged so that it is practically a new water-way. In the line of the Butte ditch are the Slabtown reservoir and the Petty reservoir, which together will ultimately contain sufficient water to run the plant at full load continuously for over a week, and in their present uncompleted state their capacity is sufficient to run the plant at full load for nearly three days. The length of Butte ditch from the tunnel to the pipe inlet is a little less than five miles and its route is along mountain tops where practical immunity from injury is assured.

The head of the pipe line is in a location that should win fame as a point of observation, for being situated more than a thousand feet above the turbulent Mokelumne River and commanding a view over rolling,



PROFILE OF THE BLUE LAKES WATER SYSTEM.

wooded mountains to Stockton, thirty-nine miles away, or sometimes even to Mount Diablo, seventy miles distant, the reward which awaits the one who has the hardihood to climb the mountain, abundantly repays the exertion. The ditch proper terminates in a massive concrete structure which serves as a combined forebay and settling basin, the whole construction being of the most permanent type. A short distance above the penstock is a spillway, carrying waste water down a canyon independent from the route of the pipe line. The supply for the penstock is taken from well toward the surface



A Mountain Head-Gate.

of the water in the ditch and is carried through double sets of strainers before entering the pipe line. An extension made in line with the ditch itself forms the waste gate and overflow weir, the water from which is carried down another independent canyon on the opposite side of the pipe line from the canyon into which the spillway empties. This extension forms a settling basin carrying water nine feet deep, and is, of course, provided with the usual mud gate for blowing off all settlings.

From the penstock the pipe line continues a distance of 3,240 feet in an absolutely straight line, down the contour of bedrock to the "Y" branches at the power house, and which gives a head of 1042.75 feet at the wheel nozzles.

The accompanying profile of the pipe line also contains the plan of the pipe line, together with the location of the head of Butte ditch and the power plant and tail race. The first 80 feet of the pipe line consists of from 48 inch to 24 inch steel slip joint pipe, of No. 8 and No. 10 steel; then follows 760 feet of 24 inch steel slip joint pipe, the first two-thirds of which is laid at a grade of 39 per cent, the remaining third being at a grade of 1 per cent. The next 200 feet of pipe line is of riveted steel pipe, joined by cast steel flanges and having an inside diameter of 24 inches and ranging in thickness from 1-4 to 1-16 in. About in the center of this section begins a grade of 47.5 per cent, which continues for about a third of the ensuing section (the remaining grade of which is at 22 per cent) consisting of 700 feet of riveted steel pipe having an inside diameter of 22 inches. The final section consists of 1,500 feet of lap welded steel pipe, having an outside diameter of 22 inches, and containing four grades of practically equal length, consisting of 39.2 per cent, 66 per cent, 32.6 per cent and 41 per cent from the top respectively. The "Y" branches embody a length of 16 1-3 feet in the pipe line, whence follows the pipes leading to the water wheels independently, consisting of steel lap welded pipe, having an outside diameter of 16 inches and the greatest length of which is 58½ feet. The elevation of the floor of the power house is 624 feet above sea level, the nozzles are at an elevation of 626 feet. The lower section consists of lap welded steel pipe, having a thickness of ⅜ of an inch to ½ an inch. Cast iron male and female flanges are used, the female end pointing up hill and the heaviest section weighing 1½ tons. Sheet lead gaskets are used under a compression which reduces the thickness of the lead from ⅛ of an inch down to 1-9 of an inch. Sections of 15-inch pipe joined with 14 bolts, using lead gaskets after this manner remained tight under hydrostatic test until a pressure of 1,200 pounds per square inch was reached.

The accompanying views illustrate some of the interesting conditions under which the pipe line was laid. The mountain is practically of rock surfaced with soil that along the route of the pipe line is of various thicknesses up to 25 feet. Soil of this nature is more or less treacherous in wet weather, and to prevent any possibility of the pipe line being carried away by land slides, it was determined to not only lay it on bedrock throughout its entire length, but also to cement it thereto. Some of the difficulties attending this work are here illustrated, but the most serious obstacle occurred in making the cut shown in the view on page 9, which is about 25 feet in depth. The loose, treacherous character of the soil made

Data Concerning the Principal Alpine Reservoirs.

Reservoirs.			Dams.			Storage Cap'ty of Reservoir in Mill'on Gals.
Names.	Area of Catchment Basin in sq. Miles	Area of Reservoir in Acres.	Maximum Height in Feet.	Length on Top in Feet.	Cement Masonry in Cubic Yards.	
Upper Blue Lake.	3	440	42	900	8,181	3,000
Lower Blue Lake.	2	200	49	1,003	8,556	1,777
Twin Lakes.....	1.5	160	26	1,488	4,869	585
Meadow Lake....	4.5	168	70	620	10,190	2,750
Upper Bear River	12	159	70	710	12,600	2,470
Lower Bear River	13	295	70	1,670	24,800	3,940
Cold Creek.....	20	275	70	1,220	25,320	3,560
Deer Valley.....	11	...	102	.....	.....	2,860

Total Storage Capacity: 20,942 million gallons.

it hazardous to dig the trench without spragging it with heavy timbers, as is done in mining. The pipe line is underground for its entire length, which so supports it that crushing from atmospheric shock is believed to be impossible. The trench for about 400 feet at the lower end of the pipe line was blasted out of solid rock and

after being laid therein the pipe for this distance was cemented in place with concrete filling and in addition the entire length of the pipe line from a point about a third of the distance from the top was anchored to bedrock by being cemented thereto by concrete at each joint pit. A more perfect method of preventing slippage in the pipe line could hardly be conceived. The lower end of the pipe line terminates, as stated, in three cast steel "Y" branches which lead direct to the water wheels. These "Y" castings are of half-inch, open hearth steel, having a tensile strength of 60,000 pounds and weighing 2,400 lbs., 2,500 lbs. and 2,700 lbs. respectively.

The problem of delivering the pipe along the line was solved by first digging the trench to bedrock and then hauling the pipe sections two by two over the route on a small cart pulled up by means of a rope of 3-8 inch steel wound on the drum of a logging engine located at the foot of the hill. This cart was four-wheeled and mounted on independent axles, generally so placed that the greater part of the load was borne by the rear axles, while the front wheels were provided with a tongue, by means of which two laborers steered the vehicle along its proper course. The rear truck was equipped with a system of toggle levers controlling a chain and saddle that secured the pipe firmly to the truck.

AT THE HEAD OF AMADOR CANAL.

Part IV

THE POWER HOUSE.

It is a sixteen-mile stage ride from the railroad terminus at Valley Spring to Blue Lakes City, as the little settlement at the power house has been named, and it is a ride of oft-recurring interest. One is interested in winding his way up the tortuous foothills of the great Sierra Nevadas; he is interested in the unexpected panoramic bursts of dale and forest and mountain scenery, and too often indeed is he interested in speculating upon the chances of life or death from the rude treatment of the relentless stage coach as it devil-may-cares its calloused, wicked way madly over the be-bouldered roads. It is then, if he be a solitary passenger, that one is interested in determining whether he has, by some black magic, become transformed into a battering ram and pile driver mechanism, alternately. Wondrous indeed is the flint-heartedness of the driver; yet more wondrous is it that flesh and blood survives the ordeal and emerges therefrom in a condition other than that of jellied concretion.

The scenes change quickly and at last hope rises when from off a great elevation one looks across a charming landscape and sees, eight miles away, a clearly defined line run down a mountain side as true as though drawn on the living picture by a ruler. It is the pipe line. Straight ahead and four miles below is the town o. Mokelumne Hill, and down, down the mountain road the stage bumps one and thumps one until, when at last the town is reached, the solitary passenger can not but think, "Why call the town a 'Hill' when it is half way down to perdition?" and then he is liable to satisfy himself with the thought that the original name must have been refined by using the vowel next down the scale, so that it becomes, as now, Mokelumne "Hill." But the delusion that the town was misnamed does not linger

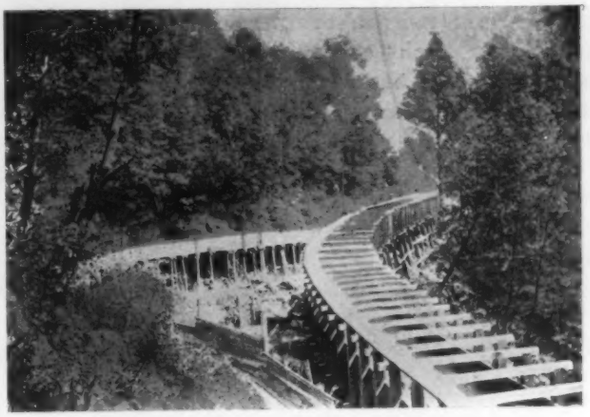
long, for, in continuing on to the destination, the conveyance suddenly commences to drop, and drop it continues to for two miles further down one of the bluffest, roughest, toughest hills that man or beast ever dared to tempt Fate by traveling. Then, Blue Lakes City, where the dust begrimed traveler offers the sincerest of thanksgivings that he is all there.

The power house is located about one-half mile above Big Bar Bridge, which is on the well-traveled thoroughfare connecting Mokelumne Hill with Jackson and the other cities in Amador County. The country is the scene of the unparalleled mining activity that will be ever memorable in history as the territory worked by the indomitable miners of "the days of old, the days of gold, the days of '49." On every hand the scenes of their activity are indelibily impressed and in traversing the country one becomes dumbfounded in contemplation of the amount of work performed in the search for the untold treasure that was there but was loosely hidden. Hundreds and hundreds of thousands of tons of soil were turned over, shovelful by shovelful; mountain-side after mountain-side was washed down and "panned"; scores upon scores of claims were worked, abandoned and then reworked, finally to pass into other hands to be worked again, while in many locations prospectors' tunnels are more plentiful than were ever rabbit burrows. To-day, but little more than the surface has been mined and deep in the earth, within easy power-transmission distance from the Blue Lakes plant, is hidden golden treasure that only the ingenuity and labor of generations can exhaust.

THE FLUME AT BALD ROCK.

The power house containing the machinery that will be indispensable in the development and future working of the region, consists of a most substantial building, 35x100 feet in size and but one-half of which is now utilized. The illustrations presented, together with the outline drawings on pages 14 and 15 are comprehensive. The cap stones of the building are at an elevation of 630 feet above sea level and the structure is longitudinally divided into two floors, the upper or switchboard floor being 2½ feet above, and the lower or generator floor being six feet below the surface of the cap stones. The north side of the power house site was blasted from solid granite, and the whole structure is built on the same bedrock. The generator and water wheel foundations rest on granite at a depth of 9 feet, as do also the piers supporting the steel columns. These piers are of rich concrete and the spaces between them are filled in with stone masonry laid with cement joints. The building proper consists of a steel frame over which is placed a wire netting covering all sides and the roof. This netting supports two layers of asbestos paper, then two layers of tarred paper and finally heavy corrugated iron, which construction affords the surest safeguard against condensation. A ten-ton steel traveling crane traverses the length of the building and the interior of the station, being painted white, presents a most pleasing appearance. The ideal compactness of the generator and water wheel sets forms the most striking feature of the installation. These are placed 3½ feet apart and each unit of 600 horse power is contained in a space measuring 11½ by 12 by 7 feet.

In addition to the power house and the cottages of its employees, Blue Lakes City contains the general offices of the operating department of the extensive system of the Blue Lakes Water Company. The entire system is connected by over 120 miles of private telephone lines and the Bell Company is now extending its long distance service to the new town. Recently the hill back of the settlement has been terraced and put in grass, flowers and fruit trees have been set out, and without doubt at Blue Lakes City is to be found the most attractive power house site of any transmission plant on the Pacific Coast.



A FLUME OF THE AMADOR CANAL.

Part v

THE HYDRAULIC PLANT.

The water is led from the "Y" castings to the wheels through steel pipes, having an internal diameter of 15 inches, with a thickness of ½ inch and tested up to 1,000 lbs. These terminate in the main gates appearing at the left of the wheels in the illustrations on page 19, and

the gates present the novel feature of being self-contained and having no packing. Each is a single gate operated by a worm and worm wheel, the worm wheel acting as a nut on the valve stem for raising or lowering the valve, and the worm wheel and worm being encased in the upper part of the valve proper with a vertical cylinder above which provides for the valve stem when it lifts. The entire inside portion containing the valve gearing is exposed to pressure, which eliminates the use of packing and in simplifying the construction, makes the value most compact. From the head gates the water is led direct to the quadruple nozzles of each of the three four-foot Doble water wheels constituting the hydraulic plant. These wheels are run at 600 revolutions per minute, are rated at 700 horse power and, as the illustrations show, are incased in cast iron housings which present an unusually neat appearance and as a result of which the wheels run with unusual quietness.

Direct connected to each one of the water wheels is a 450 kilowatt Stanley, two-phase inductor type generator and the marked innovation of carrying the entire set consisting of water wheel, inductor and fly-wheel, on two bearings so that the water- and fly-wheel overhang, affords one of the most radical departures in transmission practice to be found on the Pacific Coast. Indeed the symmetry and compactness of the plant is most pleasing, for, as is shown in the sectional drawing of the station, the generators are but 15 feet between centers and the three units of 600 horse power each occupy space over all of but thirty feet between the centers of the outside machines.

It is difficult to understand the ground for objections that have been made to the mounting of the Blue Lakes generators and water wheels. Overhanging bearings are used in steamship practice, which constitutes the heaviest work known to engineering. The armature of the 800 kilowatt generator of the Los Angeles Railway Company, together with the two crank discs and the hub of the fly- wheel, weigh together 98,000 lbs. and

At the Head of the Pipe Line.

Hauling Pipe Up the Pipe Line Grade.

Hauling Pipe with a Ten-Mule Team.

are mounted on a single shaft. In addition to this must be added the weight of the fly wheel, which is 45,000 lbs., making a total weight of 143,000 lbs., borne on a single shaft supported by two bearings. Moreover, a shaft driven by two engines having quartered stroke is subjected to complex strains of an infinitely more trying nature than is the shaft sustaining a water wheel giving a constant, even torque.

The weight on the shafts of the Blue Lakes equipment is but 20,000 lbs., of which the water wheel weighs 2,000 lbs., the inductor 14,000 lbs., and the fly wheel 4,000 lbs., from which it appears that the alleged objections to overhanging bearings can hardly be of a mechanical nature. Moreover, the stresses on a shaft which is not supported by overhanging bearings, but is sustained at its ends, are similar to those of a beam weighted in the center and from which must result a tendency to sag. With overhanging bearings, however, the shaft becomes as two cantilevers with overhanging weights opposing that in the center of the shaft, thereby restricting the tendency to sag. Two exciter sets each consisting of an 18 inch Doble wheel direct connected to a 10 horse-power dynamo, are located on solid concrete piers directly behind the generators. These wheels

are also provided with cast iron housings and, in addition, the frame contains a plate glass panel for viewing the action of the water on the buckets.

Another interesting feature of the hydraulic equipment lies in the use of strainers for the jets of the exciter wheels. These strainers, which are of solid cast iron construction and located on the fronts of the concrete piers immediately below the wheels, may be compared in action to that of a two way valve in that the water for driving the wheel may be instantly made to flow through either one of two courses. These courses are each provided with a strainer of brass gauze so mounted in cartridge form as to be easily removable, and the principle of operation of the apparatus lies in the feature it embodies for permitting the removal and cleaning of one strainer cartridge while the other strainer is in use. Some such arrangement is necessary for the protection of small nozzles using water under high heads in plants where the water may possibly contain twigs or leaves or bits of wood that might cause a shut down because of closing the small orifice in the jet of the exciter wheel. The jets of the large wheels, having greater orifices than the area of the screen openings are not liable to clogging from this cause.

THE BIG CUT IN THE PIPE LINE TRENCH.

From a strictly hydraulic standpoint, the most novel feature in the Blue Lakes plant is the absence of both receiver and air chamber on the pipe line. Accidents that have occurred to pipe lines have been due to water ram caused by the almost instantaneous opening and closing of gates or by collapse due to the formation of a vacuum caused by a choking at the intake or the using or escape of water at the lower end faster than it can possibly enter from the forebay. The gates in the Blue Lakes plant are so constructed that it is a physical impossibility to open or close the main gate in less than ten minutes, nor can either of the quadruple nozzles be closed or opened in less than three minutes, which arrangement it is believed allows sufficient time interval to elapse to prevent any possibility of water ram. The pipe line is without air valves in any portion, but the factor of safety in the materials used is so great and the pipe line is so deeply buried throughout its entire length and so rigidly cemented to bedrock by concrete, and as all parts before installation were subjected to a hydrostatic test of not less than double the working pressure, it is believed that breakage and the draining of the pipe sufficient to cause collapse from atmospheric shock, is an impossibility. At present the water wheels are running by hand regulation, but governors will be installed shortly and so arranged that two nozzles of each water wheel will be hooded by the governor and the remaining two will be throttled by hand should occasion require. From the wheel pits the discharged water is carried in individual courses to the tail race, whence it continues underground through an arched tunnel under the grounds of the power house, emptying into the Mokelumne river.

Part vi

THE ELECTRIC PLANT.

The generating station apparatus consists of three 450 kilowatt, two-phase, Stanley inductor-type generators, running at 600 revolutions per minute and delivering current at 7200 alternations per minute, at a potential that may be varied from 2000 to 2400 volts. These are mounted on two bearings with direct connected overhanging water and fly wheels as previously described. The exciters consist of two 10 horse power multipolar generators, delivering current at 60 volts and either of which has sufficient capacity for exciting the fields of the three 600 horse power generators. The generators are, of course, too well known to require detailed description, but the switchboard presents modifications of design that were necessary to satisfy local conditions.

Two sets of bus-bars are provided and the switchboard combinations are such that through four-pole double throw switches, either generator may be thrown on either set of bus-bars; or through four pole double throw switches, either recording wattmeter may be thrown on either set of bus-bars; or either generator may

operate either line individually through its proper recording wattmeter; or all generators may be connected in parallel, feeding either or both sets of bus-bars—in brief, any desirable combination between generators, bus-bars, and transmission lines may be effected.

Under a contract existing between the Blue Lakes

LAYING THE PIPE LINE.

Water Company and the California Exploration Company, the Exploration Company has the exclusive right to use and sell electric power from the Blue Lakes plant in Calaveras County. As the Mokelumne River forms the dividing line between the two counties, the plant is admirably situated for the execution of this agreement. At present two transmission circuits are carried from the power house, namely the Amador and Calaveras circuits.

The switchboard consists of ten panels, the first three of which, beginning the enumeration from the left, are for generators 3, 2 and 1 respectively, after which follows the exciter panel. Panels numbered 5 and 6 are for the Thomson recording wattmeters on the Calaveras and Amador circuits respectively. Then follows panel 7 for the 10,000 volt Amador County line; panel 8 for a supplementary Amador County transmission circuit; panel 9 for the Calaveras County circuit, while panel 10 is a blank, eventually to be used for the proposed transmission to Stockton. The arrangement of the switchboard and transformer features is unique, for, as shown in the sectional view on page 14, the transformers are to be mounted on a platform erected over the enclosure back of the switchboard. Down this enclosure has been constructed a skeleton board on which is run the high potential switches and circuits, all as indicated in the sectional drawing. At present the step-up transformers have not been placed in service but the generator potential of 2400 volts is put to the transmission circuits direct. Before spring, however, the step-up transformers will be installed and 11,000 volts will be put to line.

From the high potential switchboard the line circuits are carried up the wall back of the transformers and across beneath the roof, thence through the choking coils, whence they pass out to line as shown in the accompanying illustration. At the peak of the roof a choking coil measuring about 24 inches in diameter and containing 205 feet of No. 3 insulated wire is cut into each line. The lightning arresters are tapped on to the lines after leaving the choke coils, and are of the latest form of the Wirt alternating current short gap type, each of which is designed for 2,000 volts and therefore, each line has five such arresters connected in series. These arresters have only two 1-32nd inch gaps between the primary and ground, and the arrester is grounded through a graphite resistance of 400 ohms. The principle of the device is that the arc is extinguished upon reversal of the current by the cooling effects of large metal cylinders and the current is limited on short circuit by the low non-inductive resistance.

THE "Y" CASTINGS AT THE POWER HOUSE.

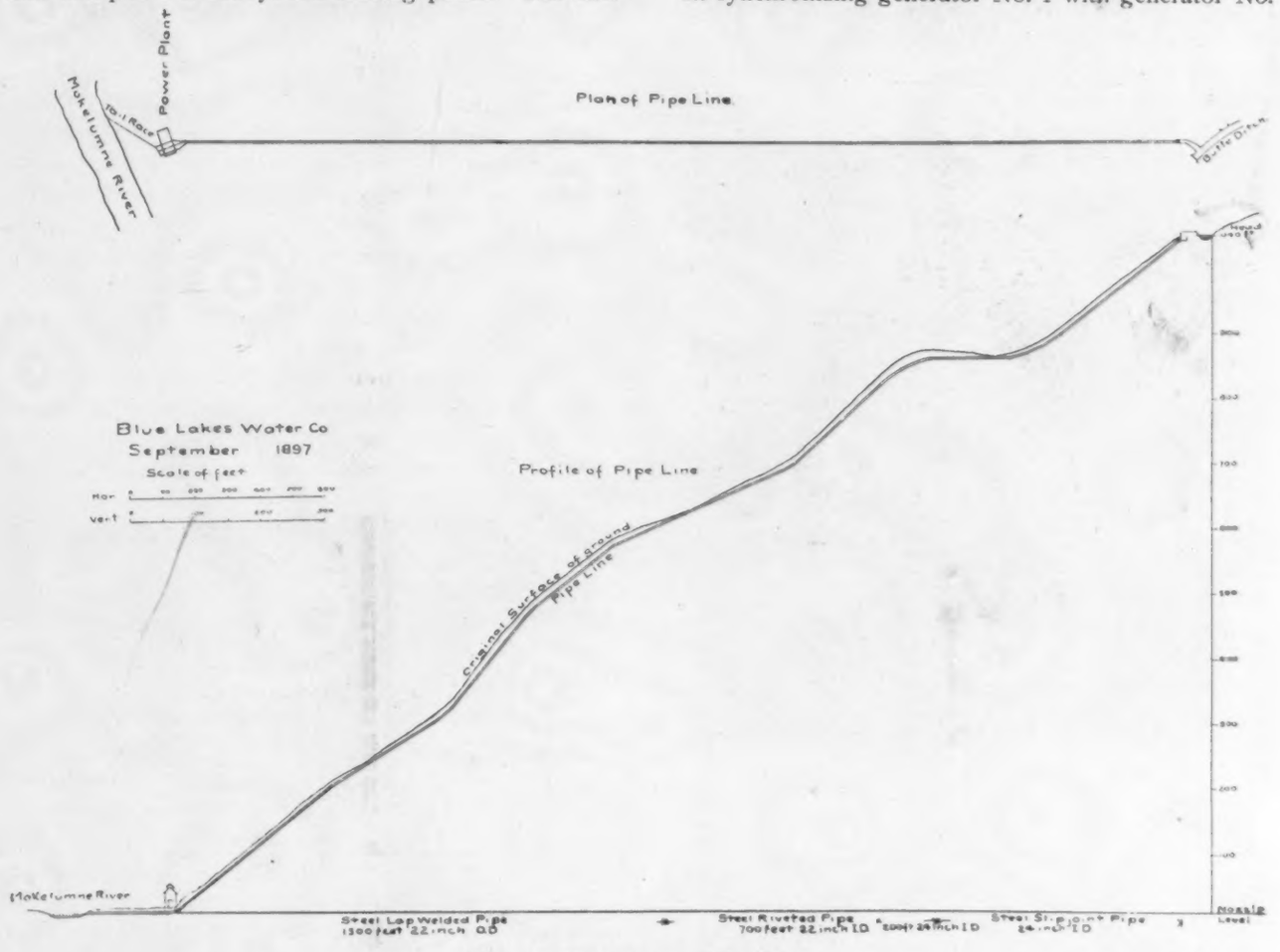
The mode of synchronizing three-phasers and the cir-

cuit connections by which this is ordinarily accomplished have been described heretofore,* and while the synchronizing of two-phase alternators is effected through the same general lines of procedure, its circuit connections are different in many respects. The means by which synchronism is attained in the two-phasers of the Blue Lakes plant are shown in the diagram appearing on page 20.

Inasmuch as in polyphase alternators the phases are fixed in relation to each other, it is only necessary in the two-phase system to take but one phase of each generator to the synchronizing apparatus on the switchboard and this phase is always the leading phase. The leading phase of each generator, therefore, supplies current to the 2000-volt transformer appearing on its respective panel, and these transformers reduce from 2000 volts to 50 volts and have a capacity of 500 watts. The only portion of the synchronizing equipment that appears on the front of the switchboard is a small U-plug switch, by means of which the circuit combinations of the secondaries of the synchronizing transformers are changed, and three pilot lamps on each of the three generator panels. The center lamp in each case is an ordinary 50-volt pilot lamp for indicating that the dynamo is in operation and the remaining two outside lamps of each panel are 100-volt lamps for indicating synchronism between its particular generator and either of the other two generators. Referring to panel No. 1 of the accompanying diagram, for instance, the pilot lamp appearing in the center is directly connected across the secondaries of the switchboard transformer. On the lamp at the left is indicated synchronism between generator No. 1 and generator No. 3, while the lamp at the right of the panel indicates synchronism between generator No. 1 and generator No. 2 as appears on the diagram, and so on through the remaining panels.

In synchronizing generator No. 1 with generator No. 2, the U-plug is withdrawn, which cuts out the plug switch from the circuit. The pilot lamps of panels 1 and 2 are assumed to be burning, but the generators are, of course, running on independent bus-bars. The two synchronizing lamps appearing as shown on panels 1 and 2 for indicating synchronism between their respective generators, are turned on by the key sockets. This done, the circuit connections of the synchronizing equipment may be readily traced.

It is to be understood that the secondaries of transformers 1 and 2 are coupled in series and feed into the small bus-bars lettered A and B. If now generators 1



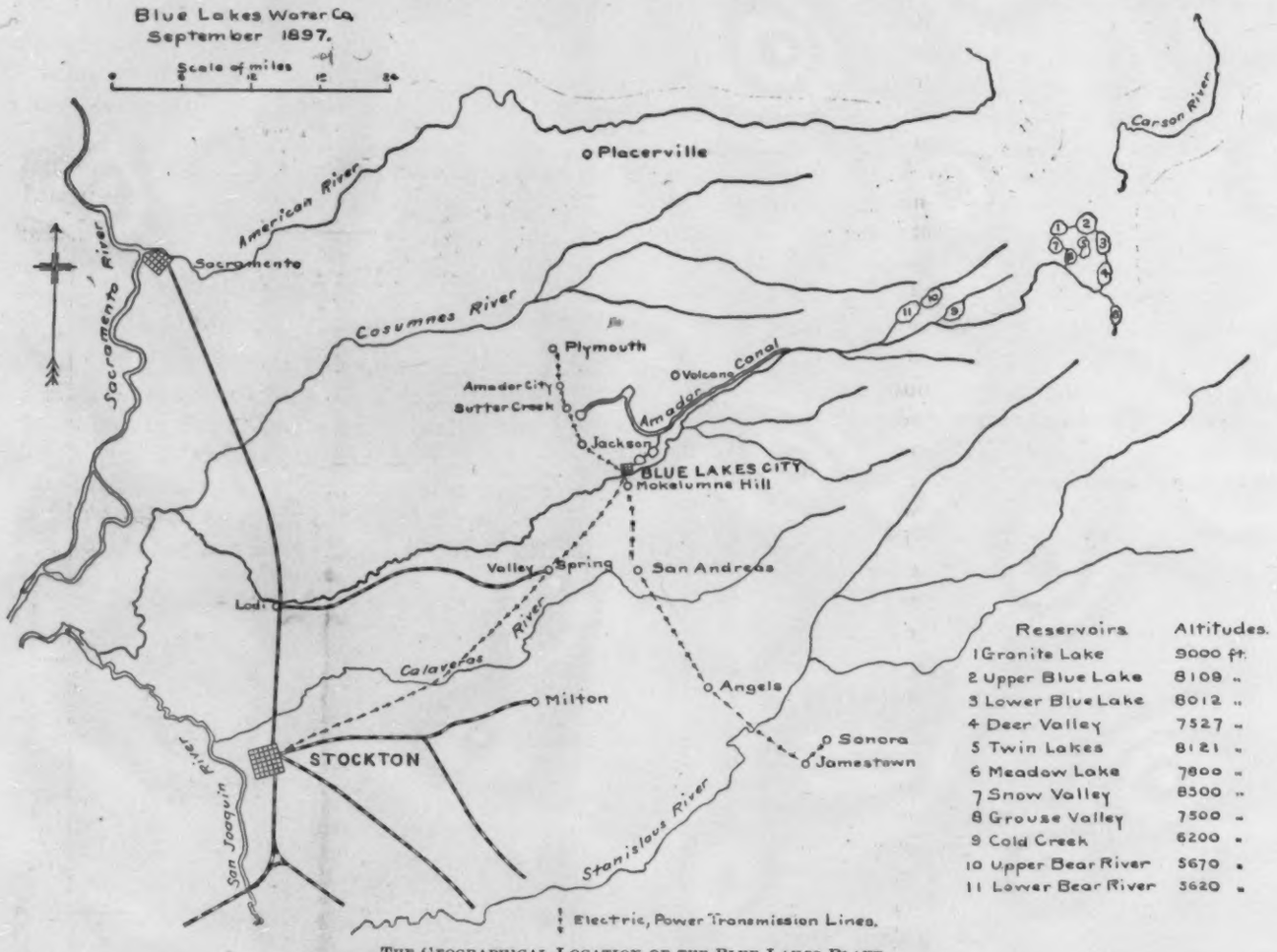
PLAN AND PROFILE OF THE PIPE LINE.

* The Journal of Electricity, Vol. IV, No. 1; June, 1897; Page 7.

and 2 are in synochronism the transformer secondaries will be in phase and their potential, being cumulative, will give a pressure of 100 volts across bus-bars A and B. If, however, the generators are out of step, the bus-bar potential will be reduced in direct proportion to the amount of drag in either generator. At intervals, therefore, the phases of the two transformers are in direct opposition and the bus-bars have, consequently a zero potential. In the next instant, the relative positions of the phases may have changed so that the transformers will be in but half opposition, giving a potential of say 50 volts to the bus-bars, while a fraction of a second later the phases may be in step giving full potential to the 100-volt lamps, which shows synchronism and at the instant the synchronizing lamps reach full candle-power, the main switch must be thrown to couple the generators in parallel.

The U-plug switch is used only in synchronizing generators 1 and 3 and generators 2 and 3, and the use of the switch merely connects the secondaries of transformers 1 and 3 and transformers 2 and 3 respectively, so that the circuits shall be in the same condition as already described for synchronizing generators 1 and 2. There is but one precaution necessary to take and that is that all synchronizing lamps shall be turned off at the key socket excepting those for synchronizing; otherwise it is possible to throw a potential of 150 volts on to the synchronizing lamps of generators 1 and 3 if the U-plug is in the wrong position.

The ease and celerity with which the generators of the Blue Lakes plant are thrown in parallel is remarkable, and those who were present on the evening of the formal opening of the plant on August 25th witnessed the three generators run independently, then saw them coupled in synchronism when finally the water was cut off from the wheels of generators 1 and 2, which were run as motors for the remainder of the evening, taking two-phase current at 2400 volts from generator No. 3. Those who question the possibility of running simple inductor generators as synchronous motors, would have had their doubts forever dispelled had they witnessed the exhibition.



THE GEOGRAPHICAL LOCATION OF THE BLUE LAKES PLANT.

Part vii

THE AMADOR CIRCUIT.

The custom of selling water by the miners inch, regardless of the head at which it is delivered, is a legacy of the early mining days when water was desired for washing gold and not as a source of power. Regardless

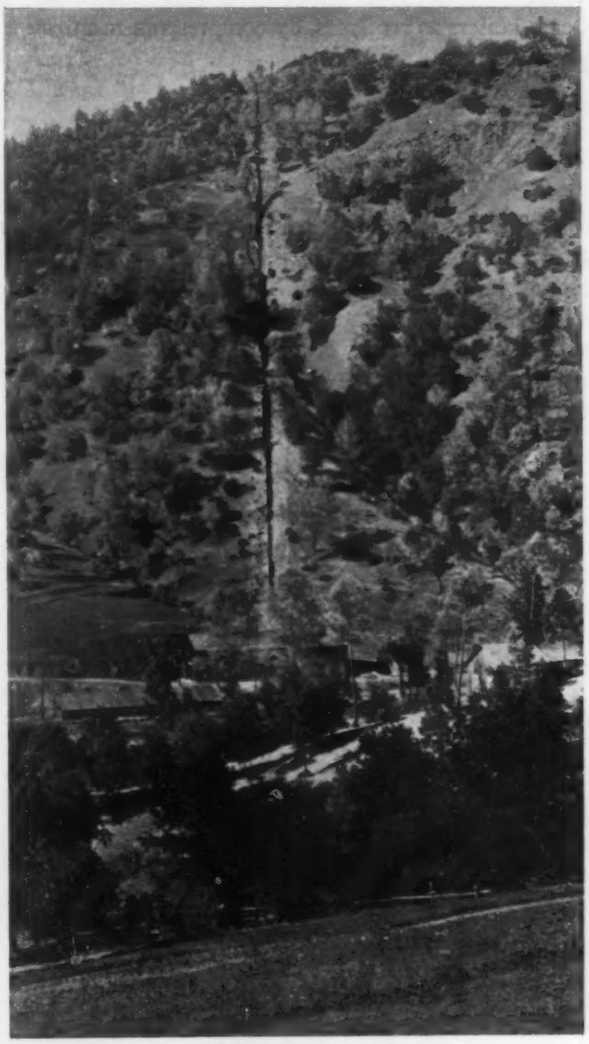
of the unfairness of charging for water used for power purposes without considering the pressure, the primitive custom is still adhered to all along the mother lode. The mills and mines are located at various altitudes and, with two or three exceptions, all are operated by water power furnished from the canals of the Blue Lakes Water Company. An average of the water consumed for power purposes by these mines shows that for each miners inch an average of but three-quarters of a horse power is produced. The electric plant generates a trifle over two and one-quarter horse power for each miners inch consumed, and it is estimated that including the usual conversion and transmission losses, power can be delivered at mines at a consumption of water equivalent to practically one miners inch per horse-power. The two or three exceptions referred to as being non-users of water power consist of mines situated at such an elevation as to render water power impracticable because of lack of head; these mines and mills use steam power for hoisting only, burning wood at a cost of from $5.00 to $6.00 per cord, and the average cost of steam power is found to be from $12.00 to $15.00 per horse-power per month. The use of coal is prohibited because of the cost of from $12.00 to $13.00 per ton delivered.

The Blue Lakes Water Company, therefore, furnishes water for practically all the power consumed by the industries of the vicinity, and now that the electric plant is in operation, it is prepared to supplant the use of water power with electric power, which in many cases presents advantages not to be found in any other form of power. It is estimated that between 1500 and 2000 horse-power is consumed or will shortly be consumed by the mines situated along the mother lode in Amador County.

The Amador circuit, after leaving the power house, follows along a private road for about a quarter of a mile to Big Bar Bridge, whence it continues up along the tortuous road climbing Butte Canyon to Butte Basin, at the base of Butte Mountain, so famous in early mining days. Passing Butte City, the pole line continues on, closely following the mother lode through the towns of Jackson and Sutter Creek and terminating in Amador City, a distance of about ten miles from the power house. Some of the most famous mines of the district are the Amador Queen, Alma, Anita, Amelia, Amador Gold Mine, Zeila, Argonaut, Kennedy, Oneida, Wildman, Mahony, South Spring Hill, South Eureka, Central Eureka, Keystone, Bunker Hill, Gover and Valparaiso mines.

The cities of Jackson, Sutter Creek and Amador have heretofore been lighted from a central station located in Sutter Creek, which was operated by water power at a head of 500 feet from the Amador canal. The Blue Lakes Water Company owns one-half interest in this lighting plant and the contract under which water was furnished for its operation gave the Blue Lakes Water Company the right to substitute electricity for the water power at its option. The change from water to electricity has been made and the cities named are now lighted from the 2400 volt generators direct, the load amounting to a maximum of 300 horse-power.

The pole line is of the most substantial type. Thirty-five foot selected redwood poles are used throughout, measuring 10x10 at the butt by 6x6 at the top, and being sunk six feet in the ground. Two twenty-two inch cross arms, gained eighteen inches between centers, are used and at curves these cross arms are doubled and framed together. All poles on curves are firmly guyed to inverted "T" guy stubs consisting generally of 8x8 redwood. Two No. 3 B. & S. gauge wires are placed on each cross arm at a separation of eighteen inches, and of the four wires carried by the two cross arms, the diagonal wires are phases. Locke triple petticoat china insulators are used throughout. The line is not transposed. At the tops of the poles, supported by porcelain knobs and grounded at irregular intervals, is run a close-barbed galvanized iron fence wire. This ground wire continues over the entire pole line and its object is to facilitate the grounding and dispersion of static



THE PIPE LINE TRENCH FROM FOREBAY TO POWER HOUSE.

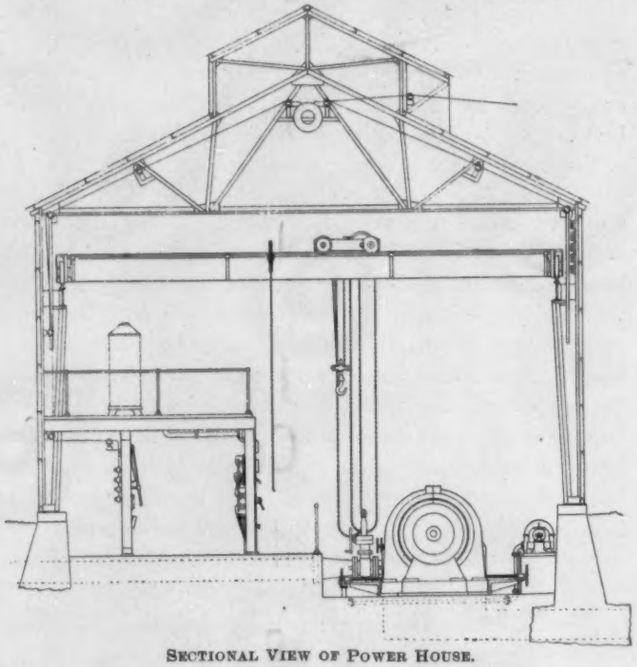
charges, thereby minimizing the liability of a lightning stroke. The country over which the Amador circuit traverses is rather a rugged one and as a result, the separation between the poles varies from a maximum of 125 feet to a minimum of 50 feet as occurs in Butte Canyon. For nearly its entire length the pole holes were blasted.

The utilization of electric power to supplant the existing sources of power in Amador County will probably furnish results of considerable engineering value. In some instances induction or synchronous motors will be belted direct to main shafts as are the water wheels at present, while in other cases smaller units will be used; for instance, one for the stamps, one for the concentrators, one for the hoists, and a fourth for the compressor. It is probable, however, that the most interesting application will be in the adaptation of steam engines for use as air motors to be driven from air compressed into steam boilers as receivers, by compressors run from two-phase motors.

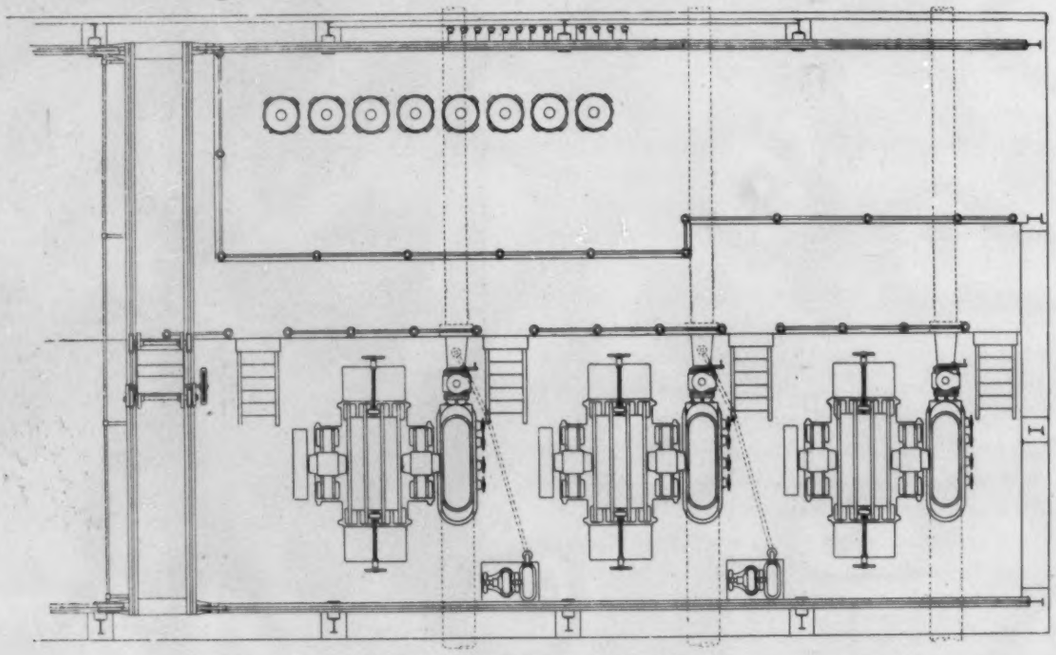
Part viii

THE CALAVERAS CIRCUIT.

The mining conditions which exist in Calaveras County differ from those of the remaining portions of the mother lode in that, although there is sufficient water for all milling and domestic purposes, there is not sufficient water available for power purposes, and to this condition may be attributed the expression of the early mining days, that "Calaveras is no good," despite the fact that the mother lode traverses it. At the north are found the magnificent properties in Amador County, while the celebrated Gwinn mine is within its confines; its central portion now holds the Gottschalk, Ford and Thorpe mines, while at the southern end are the famous properties near Angels Camp, among which are the Stickles and Utica mines, the latter bearing the distinction of being the largest gold producing mine in California. Under these conditions it was but reasonable to assume that the absence of developed mines in the central portion of Calaveras County was due to lack of water or power for working them, and not to poverty of the mother lode.



SECTIONAL VIEW OF POWER HOUSE.

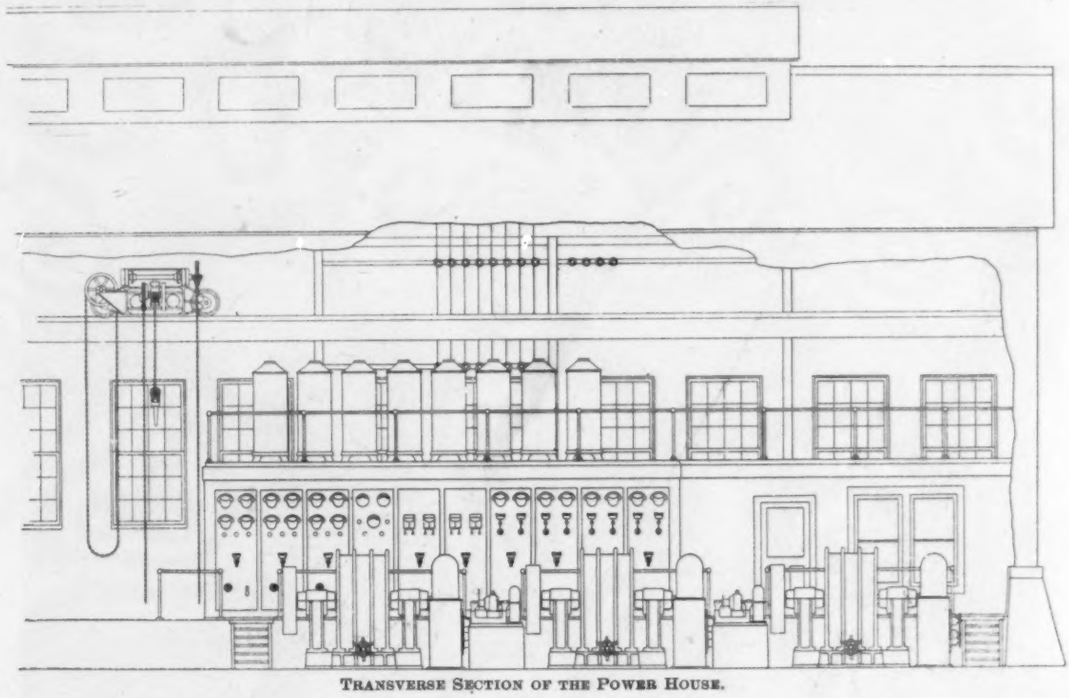


GROUND PLAN OF THE POWER HOUSE.

These were the conclusions which led Prince Poniatowski, Mr. W. H. Crocker and others, to bond over a score of mining properties situated on the mother lode between Mokelumne Hill and Angels Camp, the out-

come of which was the interesting of English capital in the development of the properties of the Company. The first move of the English members of this corporation was to secure the services of Mr. Richard A. Parker, E. M., C. E., to report upon the Calaveras properties thus acquired, and Mr. Parker's report was so favorable that active operations were begun at once toward the exploration and development of the properties. These, however, have now been increased until they number over thirty.

With a few exceptions the only mines that have been operated in the central portions of Calaveras County have been surface workings, not the least noteworthy of which was the famous Chile Gulch. The cost of development in this region has been high on account of the expense for fuel, which ranges from $4.50 to $5.50 per cord, and without water power, and with high charges for wood, mine development has been possible only for wealthy corporations.



TRANSVERSE SECTION OF THE POWER HOUSE.

After an exhaustive study of the means available for furnishing power for the exploration and operation of its mines, and after a thorough canvass of the various water powers available, the California Exploration Company resolved upon electricity as the most feasible power and entered into a thirty years' contract with the Blue Lakes Water Company under which the Exploration Company has the exclusive right for the transmission and distribution of electric power and light from the Blue Lakes plant in Calaveras County. This contract contemplates the use of from 1000 horse-power up, and really forms the basis for the building of the Blue Lakes plant.

The only distinction between the Amador and Calaveras pole lines is that the latter passes over the less rugged country; but otherwise, and in the matter of poles and materials the Calaveras circuit is identical in construction with the Amador line. From the power house the line is taken up a mountain side for a distance of one mile to the Exploration Company's sub-station in Mokelumne Hill, in which town there is nine-tenths of a mile of pole line for lighting distribution purposes. The next sub-station is in the town of San Andreas, which is 7.7 miles distant by way of the pole line from the sub-station in Mokelumne Hill. The town lighting in San Andreas embraces 2.03 miles of pole lines for low tension distribution, and from the sub-station the transmission line continues on a distance of 7.05 miles to the Bund mine, to which the high potential circuit is now completed. The total length of the Exploration Company's transmission line is at present 19.11 miles, and in all probability the circuit will soon be extended to Angels Camp, which is about five miles beyond the Bund mine. At present the 2400 volt potential of the generators is delivered direct to the Calaveras circuit, as is done in Amador County, for with the exception of the lighting load in Mokelumne Hill and San Andreas, which amounts to about 100 horse power, the only load on the circuit is the twenty horse power hoist in the Gottschalk mine. Current for the operation of this hoist, is taken from the main line before reaching the San Andreas sub-station, by means of a branch power line .43 of a mile in length.

The labor cost of building the Exploration Company's transmission line forms an interesting study, and is here presented through Mr. Parker's courtesy. Some reference seems necessary, however, to the item of surveying and preliminary work in which the expense given covers three surveys made, preliminary meanderings of

county roads and other outside work, all of which was incorporated into the one general item of survey during the time. Probably one-half of the amount stated would be a fair price for the actual surveying work put upon the line.

The cost of labor in the various items of construction of the Calaveras circuit, as given by the California Exploration Company in terms of per mile of line, is as follows:

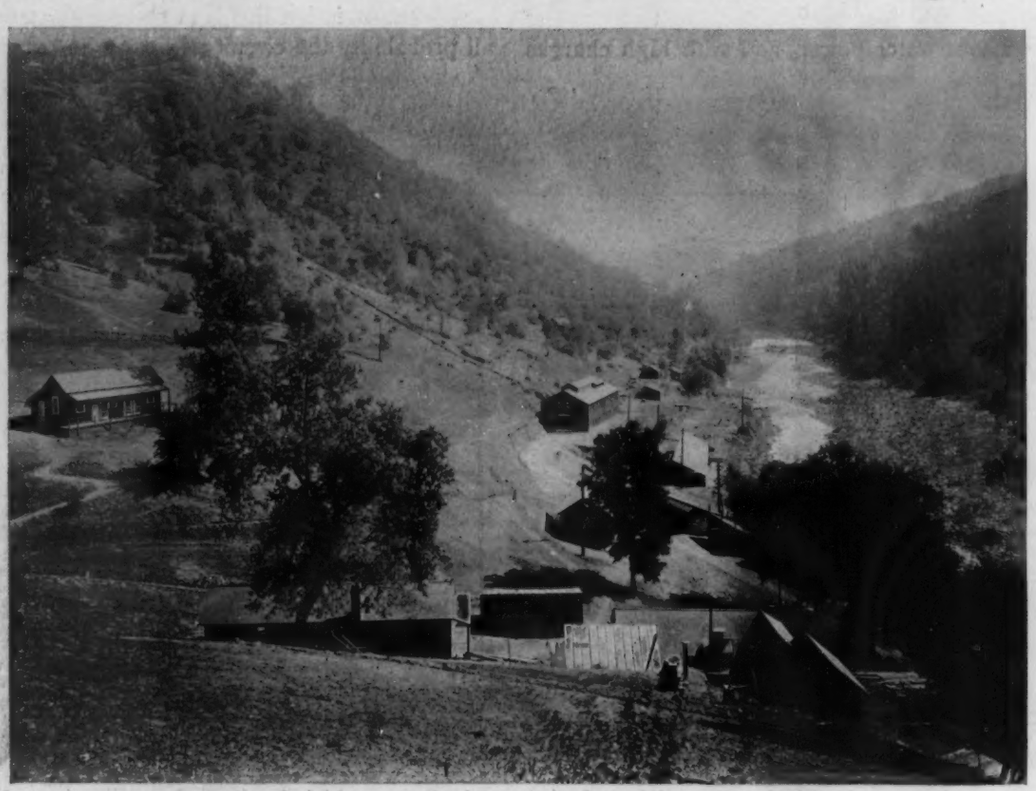
Surveying and preliminary work	$95 20
Clearing line	46 16
Digging holes	50 40
Distributing poles on line	13 20
Crossarming, gaining, etc	18 00
Erecting poles	25 20
Stringing barbed wire and guying	15 14
Stringing main line	64 20
Stringing telephone line and distributing and placing brackets	15 30
Painting crossarms	9 83
Distributing insulators, crossarms, etc	15 20
Total	$367 83

Part ix

FINANCIAL.

The Blue Lakes Water Company was incorporated April 17, 1890, but did not come into possession of the properties until January 1, 1892. The capital stock is $10,000,000, divided into 100,000 shares of $100 each, par value; the amount paid in, or rather the one and only assessment was $6.00 and was paid in 1892. The company is authorized to issue $5,000,000 in bonds, and has issued $725,000 under date of March, 15, 1893, running forty-five years and bearing 6 per cent interest. The California Safe Deposit and Trust Company of San Francisco is trustee, and although the bonds are but 6 per cent, the company is not permitted to issue other bonds without demonstrating to its trustees that whatever property may be acquired through the sale of further bonds, or whatever use to which the proceeds of the sale of such further bonds may be put, shall be able to alone earn a net interest of at least seven per cent on the face value of the bonds so issued.

The company owns all the available lands surrounding the lakes and reservoirs, and along the river, canals and ditches, the titles to which are clear and correct.



GENERAL VIEW OF BLUE LAKES CITY.

The future development of the Blue Lakes plant will depend to some extent upon the growth of the mining industry along the mother lode and the near future will doubtless see the completion of the circuit to Jamestown on the south and possibly to Placerville on the north. Preliminary steps are being taken for the building of an electric railway connecting the principal cities of Amador County with the Southern Pacific at Valley Spring or Ione, while a similar line in Calaveras County has received some consideration. More probably, however, will the building of a transmission line to Stockton, thirty-nine miles distant, constitute the first important extension of the plant. The Blue Lakes Water Company at present owns and operates the Stockton Water Works

system, and the operation of the water works together with that of some of the great flour mills of Stockton, as well as possibly its street railway system, will give an ample load for the proposed Stockton circuit. It is estimated that 50,000 horse power can be developed by the Blue Lakes Water Company at a cost not exceeding $100.00 per horse power for the complete plant, including further water development and all necessary pipe lines, hydraulic, electric, buildings, and other equipment.

Part x

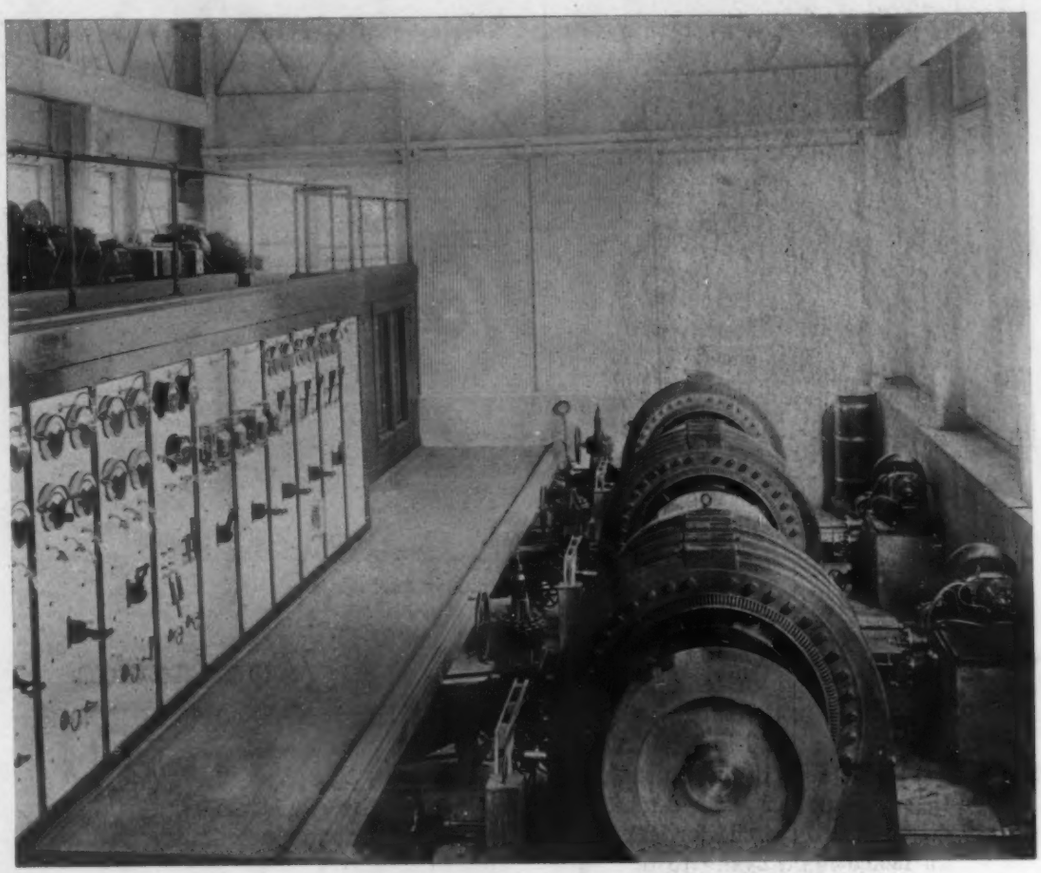
PERSONAL.

In conclusion, personal recognition should be given to the principal individuals most directly interested in the installation question.

The orginal conception of the idea of utilizing water power from the Blue Lakes system for the operation of an electric transmission plant, and of the selection of the location for the pipe line and power house, was due to Mr. Robert McF. Doble, Secretary of the Blue Lakes Water Company, and who from the outset has had personal charge and supervision of the design, construction and installation of all details in connection with the plant, and in this work Mr. Doble was assisted by Mr. Ross Morgan, C. E., and Mr. W. Stuart-Smith, E. E.

The financial features have been in the hands of Mr. W. Frank Pierce, President. Mr. Pierce and Mr. Doble, together with Mr. C. S. Wright, Vice President, Mr. Jesse W. Lilienthal, Attorney, and Mr. John Flournoy, constitute the Board of Directors of the Blue Lakes Water Company. The head office of the company is at Rooms 175-178 Crocker Building, San Francisco.

Prince Andre Poniatowski is President of the California Exploration Company, and Mr. Richard A. Parker, E. M., C. E., General Manager, with offices in the Crocker Building, San Francisco, and Mr. W. L. Honnold is General Superintendent, with offices at San Andreas, Calaveras County.



GENERAL VIEW OF THE GENERATOR ROOM.

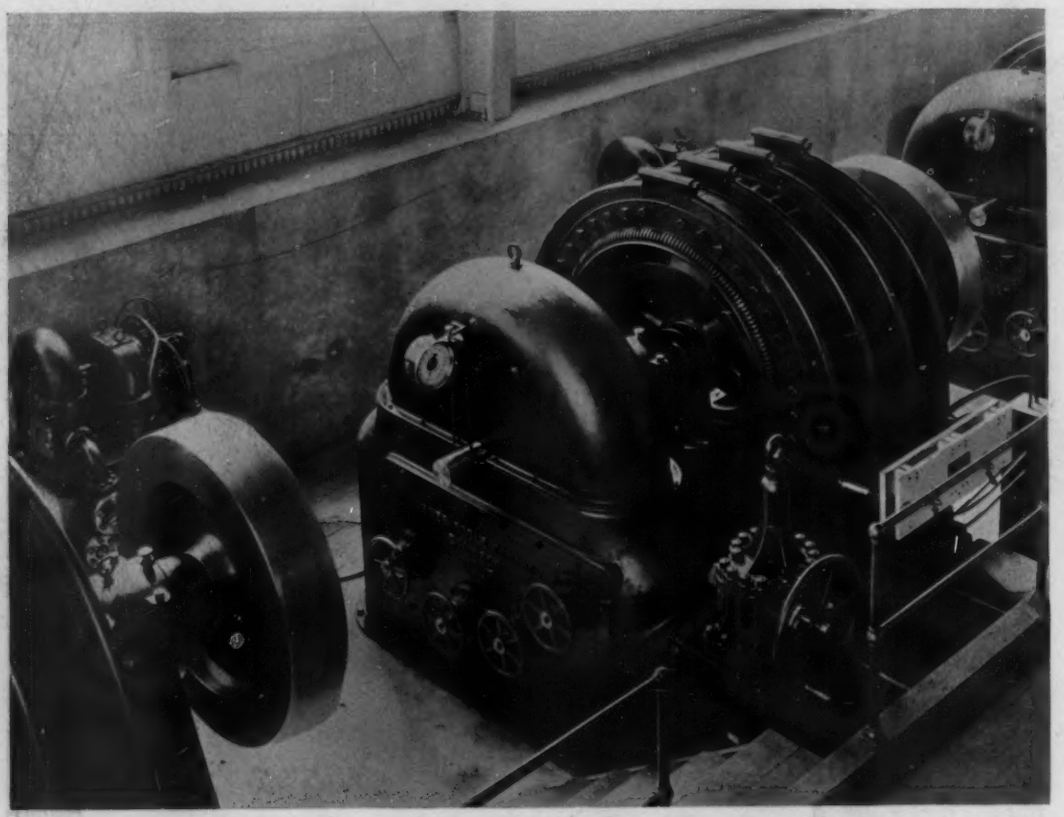
Gas

THE EXPLOSIVENESS OF ACETYLENE.

Mr. H. Schrey, in a contribution to a recent German contemporary, (Annalen fur Gewerbe und Bauwesen) states that it has been shown in experiments made by M. Ravel that 6.35 cu. ft. of acetylene gas generate 1 horse power per hour. This is equivalent to a reduction of two-thirds as compared with petroleum. As to the explosiveness of mixtures of air and acetylene, 1.35 parts of acetylene mixed with one part of air begin to be explosive, and the explosive force of the mixture rises rapidly as the dilution with air increases, and attains a maximum when 12 volumes of air are mixed with one volume of acetylene. As the proportion of air is increased

beyond this limit, the explosive force subsides, until at 20 to 1 it becomes entirely extinct. The flashing point approximates 480 degrees C., whereas in the case of most other gases used to generate power the requisite ignition temperature is about 600 degrees. The temperature of combustion is very much higher than that of the other gases with which it can be compared. Mr. L. Meyer has already called attention to the dangerous character of the explosion of acetylene mixtures. The special characteristics of this gas are accordingly: (1) Great rapidity of the transmission of flame; (2) low ignition temperature; (3) high combuston temperature; (4) extraordinary energy evolved in the explosion.

Special precautions were needed in conducting M. Ravel's investgations, as the force of the explosion was more violent than that of any other known mixture of gases. It is very dangerous to search for leakages of acetylene gas with a naked light, owing to the highly explosive character of the mixtures of this gas with air. It was found necessary with acetylene to employ twice as much lubricant for the cylinder as when using coal gas, and the cooling of the cylinder has a much more important effect upon the working of the motor than is the case with coal gas. In a small 2-horse-power motor the actual working showed that acetylene gas gave 2.1 times the work of the same volume of illuminating gas, and the contrast would be doubtless greater still in large motors. The employment of acetylene in gas engines of the type in common use would not, according to Ravel, be expedient for reasons given, but in a large engineering works in Italy some acetylene motors are being constructed for bicycles, with the intention of employing in them a mixture of one-sixteenth of acetylene to fifteen-sixteenths of atmospheric air. These motors are intended to be run at 600 revolutions per minute, and to go for 15 hours without recharging. The weight is 19.8 lb., and the working cost is set down at 12 cents per hour.



One of the Doble Wheel and Generator Sets.

Illumination

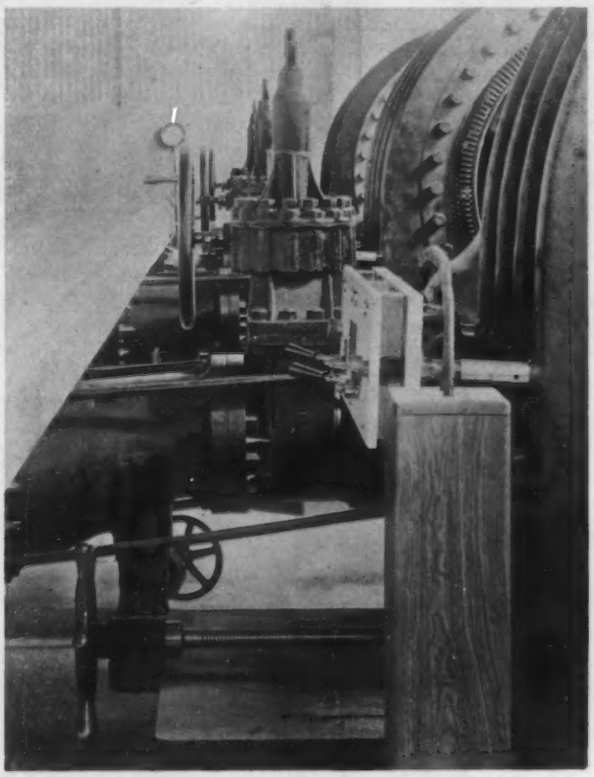
EUROPEAN AND AMERICAN PRACTICES.

By J. McGhie.

The outcome of a hurried visit to England and France is, perhaps, not so much the acquisition of the idea that both of these countries are hopelessly behind in the race, electrically speaking, with the enlightened sons of Uncle Sam, as the receipt of a very strong impression that they are much farther ahead than we have been led to suppose from the reports of the veracious foreign correspondents of the daily press. True it is that electricity has by no means become the handmaiden of daily home and business life as it has on this side of the Atlantic, but, freed from the bumble-like restrictions placed upon its adaptation by sundry parliamentary wiseacres in the early eighties, when the industry needed most encour-

agement, it promises to become as widespread in its use in the United Kingdom as here in the United States. The period through which this country passed some eight years ago, when the boom of electricity in the lighting as well as in the railway branches enveloped every town and hamlet, has for some time dawned in Great Britain and France, and there is plainly evident a marked avidity to acquire as soon as possible a better means of illumination than is afforded by very poor and very poisonous gas, and a better method of transit than the poorer horse and the hearse-like tramcar.

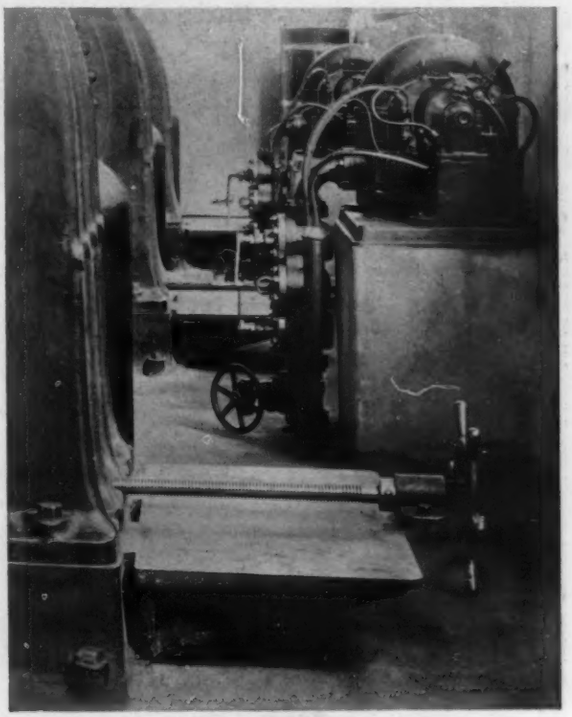
The lack of private initiative, however, which has prevailed during the past few years is strikingly apparent. Under the Governmental restrictions imposed upon it, electricity as a field for investment presented few or no inducements to capital, and where in the United States thousands of dollars were poured out for the purpose of installing stations and spreading the use of the current, it seems to the ordinary observer that in England and France pennies only have been invested, and those with a niggardly hand and suspicious mind. The confidence in the future universal use of electricity which characterized the pioneers on this side seems to have been almost entirely absent from the minds of the men on the other;



THE MAIN GATE VALVES.

and that which is here termed European conservatism is simply either a pure lack of appreciation on the part of the English or French, or a determination to do nothing until, by the experience gained in the United States, capital could see its way clear to the assurance of a profitable return. Any lack of appreciation, however, is rapidly giving way before the active propaganda now being carried on. Indeed, it may be said to have already made way for a very lively realization of the positive benefits to be derived from the use of electricity—a realization of which certain American companies, with an eye kept vigilantly open for future business in Europe, have already taken advantage.

To glance over the list of projected companies having the utilization of electricity as a basis for their appeal to

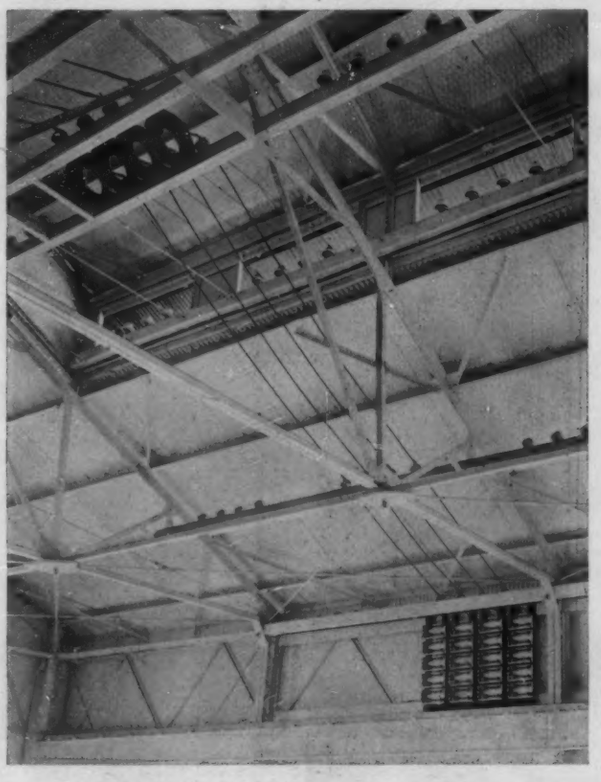


THE EXCITER SETS—SHOWING THE STRAINERS.

the public in England, that country of easy flotations, is calculated to make one believe that the electrical millennium is near at hand. Hardly a city or town, however important, or a little Peddlington, however insignificant, but is desirious of having a station within its limits, and if the public were as sanguine as the promoters there is little doubt that the boom of electricity would assume overwhelming dimensions. It is, perhaps, fortunate that the mysterious "je ne sais quio" which to the untutored envelopes all things electrical is still unpenetrated by the general public, otherwise England would probably see another panic such as was caused by the collapse of the great boom in the early days of railways. In view of this, an immediate widespread extension may not, therefore, be looked for, but instead a healthier, steady, and cautious increase.

It is not until the visitor has left Liverpool, where he lands, that the still chary use of electricity makes itself felt. The first impression gained from a view and a trip over the Liverpool Overhead Railway is that he has dropped among a distinctly electrical people. Here is a road which enjoys the distinction of being the first permanent elevated electric railway in the world, be-

tween six and seven miles long, running the entire length of the magnificent estate of the Mersey Docks and Harbour Board, from the Dingle to Seaforth. It is run without hitch or accident, and traveling upon it is a distinct pleasure. The road is phenomenally smooth, and the perfect manner in which the train service is carried on is a delight. Although this road was installed in 1893, and was preceded and followed by important subterranean electric railways in London, it is a strange fact that comparatively slow progress has been made in

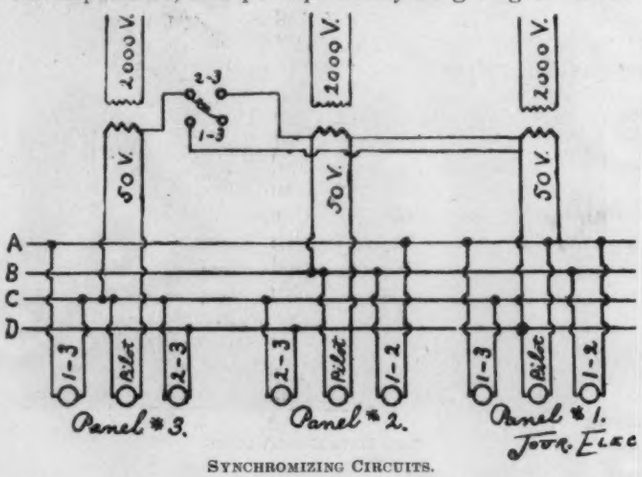


CHOKING COILS AND LIGHTNING ARRESTERS.

the adaptation of the electric motor to the street railway systems. It is as though the country had paused for breath after the exertion.

After leaving Liverpool, electrical installations of all kinds become markedly sporadic. Electric lighting is still a luxury to be enjoyed with the pride of possession, or gingerly with the satisfaction that comes of playing with a half understood and dangerous plaything. The pushing little private company, securing with a hurrah and the expenditure of a little palm money a franchise for nothing from a venal or semivenal board of aldermen, is practically unknown. The installation of an electric lighting plant is a matter of grave concern to be approached with a seriousness befitting the case. And here is apparent the extent to which municipal socialism has crept into English city life. A large number of the electric lighting plants concerned with city lighting which have been installed are not private but municipal, owned by the city or town, and operated by the corporation officials. To the American imbued with the knowledge that any municipal plant would prove a municipal curse in the hands of the politicians—this ownership and operation of electric lighting plants by the cities themselves is a source of wonder by no means diminished by a visit to the station and an examination of the accounts. It may be the thin end of the socialistic wedge leading to eventual universal State ownership, but so far as England is concerned the apparent results are gratifying. The process by which these are obtained is simple. The decision to acquire or establish a plant by a municipality is followed by the retention of the most talented consulting engineer it can afford—such men as Dr. John Hopkinson and Prof. Kennedy, for example—and the advice of this engineer is followed and not set aside for that of some man with a pull. The estimates are honestly called for and honestly treated, and the result is without exception the purchase of the best available machinery the town can pay for. The deliberation accorded the project, though to us somewhat slow, receives its compensation in the perfection of the result achieved. The erection of the plant is followed by the engagement of a competent operating engineer, and in his appointment the role played by "inflooence" is very minor. It is not a political position to be given away as compensation for value received, and it is held so long as the incumbent behaves himself. There is no dismissal on account of political differances and no retention on account of political services. The same rule applies to all the positions connected with the station. The net result of the injection of a little honesty into these municipal matters is a plant which is the pride of the taxpayer instead of a yawning gulf of expense.

The impression gained from a visit to English or French central stations is essentially agreeable. Instead of a station containing half a dozen different makes of dynamos, some driven by belt and some directly connected, with a switchboard on which all makes of instruments are discernible—a station which has grown up with experience of a costly interest-devouring nature, a concrete history of the development of the art, so frequently found here, the despair of the manager and the haunting bete noire of sundry shareholders—one finds a perfect whole, carefully designed and executed with thoroughness. One is not confronted with the "Oh, it'll do" earmarks of expediency. It is usually a consistent installation throughout. Indeed, there are but few stations in America which can compare in finish of detail, symmetry, and general perfection with some of the recent installations which I had the pleasure of seeing in England and France. It should be remembered, however, that both these countries have profited largely by our experience, and perhaps I may be giving them too



SYNCHROMIZING CIRCUITS.

much credit for avoiding the rocks and shoals which we encountered in our pioneer work. We have the apparatus, but do not seem to dwell largely enough upon the necessity of absolute thoroughness throughout the station. At the stations of Croydon, near London, and Versailles, near Paris, the cleanliness, neatness, and general consistency is noteworthy, and yet in each of these stations apparatus of American make alone is used.

One striking difference between English and American practice lies in the willingness with which the manager of an English station will give another valuable information regarding his experiences with his own plant. Here, our managers, outside the Edison fold, are as silent as carp regarding their methods of management, economies induced, and results achieved. They are "giving away no wrinkles" to the other fellow. He might some day become a competitor. He never does; but silence is golden, and thus much useful knowledge is withheld.

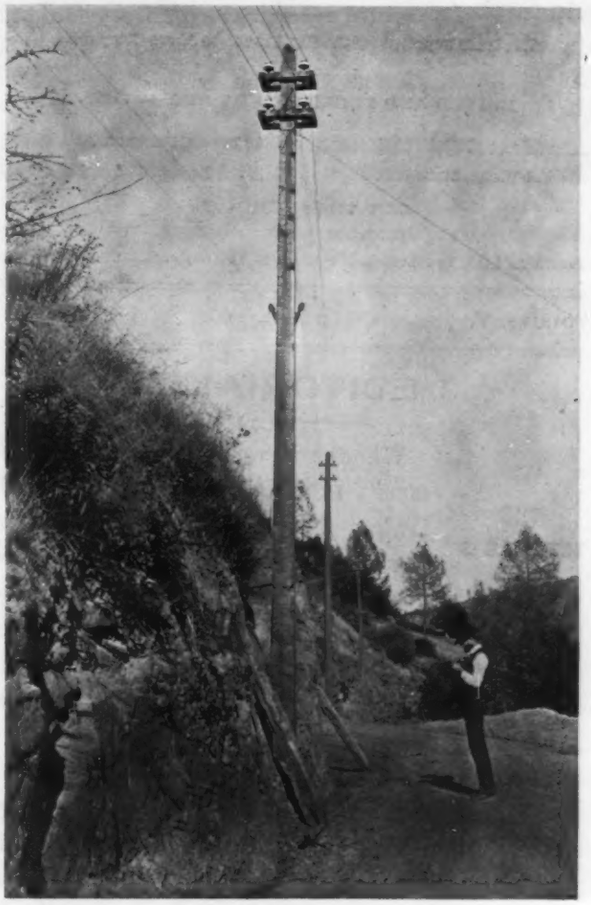
As I said before, electric lighting is still a luxury. This remark applies more strongly to the use of the current in houses and stores. Street-lighting by electricity is becoming very general in both countries, and both London and Paris have now very creditable services. During the past two or three years the incandescent lamp has had an arduous struggle against the mantle gas burner, the application of which did not necessitate the cost of a wiring installation, but it affords me pleasure to say that this light has been found so trying that it is rapidly dwindling in popularity. This assurance has been given me by lighting-station managers who have felt the competition. In France, where the gas companies are more powerful, the mantle gas burner is still a very active competitor. An excellent indication of the increasing use of electricity for lighting purposes lies in the fact that the manufacturers of gas fixtures are now turning out large quantities of fixtures wired for incandescent lamps. Such an increase can only have had one cause—the increased use of current.

The business in electrical appliances and supplies is healthy in tone, and manufacturers are crowded with orders. English and French appliances are, as a rule, made with a little less utilitarian aspect than are ours. Their snap switches, fuseholders, cut-outs, etc., are not so homely. There exists a desire to render them artistic, and they can thus be used in places where our rosettes, cut-outs, etc., would need boxes to hide them in. American manufacturers of lighting supplies, before entering into competition with English manufacturers, would perhaps do well to study carefully the character of the demand before attempting to press upon the market the appliances which are accepted here. I noticed in many stations that American measuring and indicating instruments, as well as recording watt-meters, were used. To my enquiries I received replies very flattering to the manfacturers.

The most marked advance electrically made during the last two years in England and France is in the railway field. The urgent demand is for an improved method of traction, and both countries are in a position similar to that in which this country found itself in the early nineties. The improved method must be electric. Cable traction is now considered out of date so far as rapid transit is concerned. Compressed-air traction is the laughing stock of all street railway engineers and managers. Compressed air has been played upon the Transatlantic public altogether too often, and mention of the compressed-air car experiments in New York, in the presence of English, French, or German engineers, usually provokes a smile of pity for those furnishing the money for the experiments. They have long ago passed that point in Europe.

Electric traction is therefore the order of the day. The success of the trolley roads in Bristol, Birmingham, Dublin, Coventry, Lyons, Marseilles, Havre, and those in Germany is the common incentive to reform elsewhere, and the change is sure to come, and quickly. The mnuicipal authorities of Glasgow and Liverpool have practically decided upon the use of electricity in lieu of horses.

The field for electrical traction in England and France is large, but it should be borne in mind that in England at least a large number of the tramway companies' charters carry the municipal purchasing clauses, and that committees and not individuals will have to be dealt with. Furthermore, electric railway apparatus cannot be sold upon "wind." Neither Englishmen nor Frenchmen will purchase apparatus on the mere ipse dixit of an American manufacturer, and in both countries guarantees have an unpleasant knack of being enforced by



POLE LINE IN BUTTE CANYON.

the courts. If American apparatus is to make its way in England and France it must emerge successfully from the tests which will be applied to it, and manufacturers must be prepared to find the guarantee severe in its conditions, and it will not be possible easily to buy the cancellation of the guarantee.

One thing more: Americans should realize that they have to live down considerable odium caused by the super-smartness of certain of their compatriots in former days. The English and French have been gulled on many occasions, and to term a device American implies with them a quality of second-rateness extremely galling to the sensitive American. Bearing this in mind, the American manufacturer should be able to sell goods in England. He has no tariff to act as a deterrent, and provided his products are up to the standard, success should meet his efforts.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

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EDITORIAL.

THE BLUE LAKES PLANT.

Whoever it was that compared humanity to a flock of sheep, blindly following the leader, made a cap that sometimes fits even engineers, and an evidence of it may be found in more than one branch of science. The erection of very high poles in transmission work "to reduce loss from earth induction"—that vague, undefined something-or-other that none comprehend—involves electrical engineering, and the use of receivers in pipe lines—that aping of the steam practice which finds a storage reservoir in the drum of a boiler—involves hydraulic engineering; while it is probable that no branch can stand acquitted of the charge that it is not in one way or another, blindly persisting in following a certain course of procedure, simply because others have gone that way before.

The Blue Lakes plant is deserving of marked distinction, if for nothing else than for the boldness with which it has departed from several well beaten and circuitous engineering paths, and the directions of these paths are indicated in the leading article of this number. Particularly are innovations introduced in the hydraulic equipment, for there is to be found at Blue Lakes City a pipe line over thirty-two hundred feet in length, delivering water at a head of over a thousand feet, which is absolutely without either air vent, relief valve, air chamber, or receiver of any kind. There are hydraulic engineers the world over who would stand aghast at the mere suggestion of building such a pipe line and who would ask in ridicule, "who ever heard of such a thing," overlooking the fact that new things are heard of daily.

The ideas which have prevailed in the construction of the Blue Lakes pipe line have been to accomplish a single direction of flow and an easy acceleration of the water, coupled with a high factor of safety, absolute rigidity and slow moving valves in the pipe line. The pipe tapers in diameter by easy graduations, and the acceleration of the water increases by correspondingly easy stages until the "Y" castings are reached, when the speed grows more rapid until a spouting velocity of about three miles a minute is attained, and nowhere do sudden changes occur either in its speed or direction. The main valves can not be closed in less than ten minutes, which prevents the possibility of water ram, and should a break occur, draining the pipe line, and subjecting it to atmospheric shock, the substantial manner in which it is buried, the lower portion being in solid concrete throughout, will support it, so that in rendering flattening impossible, it will prevent collapse.

The further innovation of mounting water and fly wheels on overhanging bearings is too fully discussed elsewhere to require further treatment here, but the perfect satisfaction that has thus far attended the operation of the plant practically confirms the correctness of its engineering design, and without doubt the radical departures there introduced will prove of epoch-marking significance in the annals of hydraulic engineering.

WHERE THEORY FAILED.

When the New York, New Haven & Hartford Railway Co. first took up the third rail conductor system to replace the overhead trolley, the electrician in charge consulted a large number of electricians with varying results; most of these experts said there would be an enormous waste of current by leakage from the third rail, which has a potential of 600 volts. The system was tried, however, and acording to the American Engineer, Car Builder and Railroad Journal, actual tests gave the following results:

The line consisted of seven miles of third-rail conductor, a return through the T-head service rails, two miles of copper cable from the power house to the track, with all joints copper bonded. At the first test trouble was experienced from leakage. The test was made after a storm, while the ground was wet and conditions very unfavorable, and a leakage of 2.6 amperes was discovered. It was afterward found that the truckmen had driven a spike through the white metal cable covering, and thus destroyed the insulation. The wires were

found melted through, amounting to one-third the section of the cable. The second test was made on a dry evening with favorable conditions, and a circuit leakage of 0.5 amperes was found. The third test was made while the track was flooded with water for a distance of about two miles, though the motor cars continued their regular trips and no inconvenience was experienced at the station. A trolley street line took its current from the end of the third-rail conductor, and continued at its regular speed notwithstanding the fact that the third-rail was connected with the return circuit through the service rail by a water bond.

The fact is that the conductors are so large and their resistance is so small that there is no inducement for the current to leave the rail for a poorer conductor.

CENTRALIZING RAILWAY POWER STATIONS.

The Electrical Engineer (N. Y.) for October 7th describes, with detailed plans, the new 70,000 horse-power central station to be erected by the Metropolitan Street Railway Company in New York City, on a site close to the river front bounded by Ninety-fifth and Ninety-sixth streets and First avenue. Aside from its magnitude it will be one of the most noteworthy installations ever erected and for boldness of design the plant must stand as monumental in engineering annals.

The building will rest on a foundation of 8,000 piles covering the whole site, which measures 201 feet by 270 feet. Its coal storage bins will have a capacity of 9,000 tons and, being located at the top of the boiler house, will render the handling of coal by conveyors, a very simple matter. Eighty-seven water tube boilers, grouped in nests of two each, and each boiler having a nominal capacity of 500 horse-power and capable of being forced to 800 horse-power, will be installed. Provision will be made for forced draft and the chimney will be not less than 350 feet in height with an inside diameter of 22 feet. The engine equipment will consist of eleven vertical, cross compound, condensing engines —each having a nominal capacity of 4,000 horse-power, with a maximum capacity of 6,600 horse-power, and each of which will be direct connected to a three-phase generator, delivering current at a potential of 6,000 volts. The current from these generators will be conveyed under-ground to sub-stations located at proper points on the lines of railway to be supplied, and in which static transformers in connection with rotary transformers will convert the current to a pressure of 550 volts, direct current, to be utilized in the conductors of the conduit of the under-ground electric railway system, with which it is designed to supplant all horse, cable and overhead trolley railway lines existing in the city.

The woful inefficiency of operating a street railway system from several power houses located in various portions of a city and entailing increased operating expenses in the way of coal haulage, running non-condensing and using small units, together with vastly multiplying the cost of real estate, equipment and attendance, has long been appreciated, but heretofore no plant of note has combined its entire power plant under one roof, and coupled with that power plant the most modern methods for the transmission of power. It certainly seems that the credit for demonstrating the feasibility of the idea is due to the success which has attended the operation of street railway lines from power transmission circuits as is done in Portland and Sacramento, and further refinements in the system may probably be looked for in the adoption of storage batteries in the sub-stations. With these installed, the plan projected by the Metropolitan Street Railway Company would be ideal.

Without doubt, other street railway systems have planned the ultimate adoption of a similar installation, and among these cities San Francisco may be enumerated. What, let it be asked, in the light of present engineering practices, is more wasteful and extravagant than the continuing in use of separate steam plants for the operation of the cable lines of the Powell, Geary, McAllister, Market and Valencia Streets and Howard Street railway systems, when they could all be operated by motors supplied with current at high potential from polyphase generators placed in the Bryant Street power house?

IT WILL BE WELCOMED.

For some time past there has been noted a growing tendency on the part of the principal manufacturing companies represented on the Pacific Coast to favor the organization of a construction company that would embody the requisites of independence, engineering ability and financial standing. This conclusion seems to be the natural result of the conviction that the manufacturing of machinery forms an industry quite foreign to that of its installation, and while heretofore, and even at the present time, most manufacturing concerns adhere to the plan of erecting their own products, it must be said that almost without exception they have been forced into the construction business by existing circumstances, even though such action has been against their judgments. The installation of their plants is by no means a voluntary undertaking on the part of the great companies. In stating the truth that as a rule the construction departments of manufacturing concerns have generally been run at a loss, one should add the equal verity that the manufacturing industry is ready to welcome the relief that a well organized construction company would afford from the annoying and unprofitable details attending the erection of their machinery.

It is understood that such a construction company has practically perfected its organization and that the new concern will be representative not only of the leading electrical manufacturing companies, but also of recognized engineering ability, as well as of some of the most substantial financial interests of the West.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

COMPUTING THE GIRARD GOVERNOR.

In the issue of August last was given a description of the dynamometer governor used with the Girard water wheels at Bakersfield, Cal., in which it has been found that the mathematical solution then given is not correct.

Beginning at the last paragraph at the bottom of page 89, the matter should read as follows:

Let the distance from the center of the pin V to the pin attaching link L to lever E be 13¼ inches. Then we have $\frac{1313 \div 6''}{13.25} = 594.5$ lbs. as being net force which we must have acting radially outward from the above mentioned central point in order that full power may be transmitted through the dynamometer, to which must be added the effect of the other component of the forces acting at the pin H, which is equal to $\frac{758 \text{ lbs.} \div 3.76}{13.25} = 215$ lbs., and there must also be added the total initial tension of the two springs S and S, which, let us assume as 305.5 lbs. Then the total centrifugal force of all the elements swinging about the point H must be such that, when assumed as concentrated at the central point above mentioned between the springs S and S', it shall just equal 594.5 lbs. plus 215 lbs. plus 305.5 lbs., or 1115 lbs., and the central point will then be traveling, let us say in a circle 24⅛ inches in diameter and all parts will be in the position shown in the sketch. Considering now the conditions when the swing levers are thrown to their extreme outward position by centrifugal force, the central point above mentioned will travel, let us say, in a circle of 13 15-16 inches radius, then a weighted swing lever which produced 1115 lbs. centrifugal effect in the first case, will now at the same number of revolutions per minute, cause a centrifugal force of 1290 lbs., and the springs S and S' will each be increased in length 3¾ inches.

The springs S and S' must be of such proportions that when having a fixed load of 305½ lbs., an additional load of 984½ lbs. will cause them to be extended 3¾ inches.

Under these conditions the conclusions set forth in the article referred to, prevail.

INSURANCE RESTRICTIONS ON ACETYLENE

That the insurance fraternity of our cousins across the line do not look favorably upon the use of acetylene for purposes of domestic illumination seems evident from the following regulations which have been issued concerning acetylene gas by the Canadian Fire Underwriters' Association and which are reproduced from the Canadian Engineer:

First—That no calcium carbide or gas generating machine be allowed in any building insured.

Second—That generator must be placed in a separate building, constructed as follows, viz.:—Walls solid brick or stone not less than nine inches thick; roof entirely of iron or other fire-proof material; floor of cement or concrete with slight upward slope from door; entrance to be an iron or standard fire-proof door, no windows or other openings except for ventilation, which shall be through an iron pipe not less than six inches in diameter protected sufficiently through the roof and turned down at the outlet. Genators must be provided with escape pipes of sufficient capacity to allow gas to escape freely at a pressure not exceeding five inches of water. Care must be taken to deposit residue from generator at a safe distance from any building.

Third—That generator building must be located at least ten feet from a brick or stone building, or twenty feet from one of any other construction.

Fourth—That the storage of calcium carbide be limited to three hundred pounds, to be kept in air-tight metallic cases not exceeding one hundred pounds capacity, and confined to the generator building.

Fifth—That if the above regulations are not fully observed, double rates must be charged.

DETERMINING METER RATES—A CORRECTION.

The omission of a cipher, through typographical error, in the second factor of the divisor of the formula given on page 121 of the last issue, makes a correction necessary.

The formula should have read:

$$\frac{C}{\frac{746}{p} \times \frac{h}{1000}} = c$$

Where C = Cents per horse power per year, flat rate.
p = Power factor of motor.
h = Working hours of motor per year forming basis of flat rate C.
c = Cents per kilowatt hour.

In this connection it is well to add that the measuring instrument is to be inserted in the circuit between the transformer and the motor, thus making the power company stand the transformer loss and the consumer stand the motor loss. If it were not so, the factor "p" would be omitted from the formula.

METERS FOR ELECTRIC CARS.

There is considerable merit in the suggestions contained in the paper read by Mr. Caryl D. Haskins on "The Influence of Accurate Measurements upon Economic Operation" before the New York Street Railway Association and which, after describing the development of total output meters (standard designs of which exist up to 8,000 amperes with special designs up to 16,000 amperes and which give a true energy account on loads ranging from 5 per cent to 6 per cent of their rated capacity upto 15 per cent above their rated capacity), advocated the placing of a meter on each car of an electric railway system for the measurement of the energy used daily in its operation.

"Every street railway management realizes," contends Mr. Haskins, "that quite a large proportion of the total

energy generated is wasted by the careless and improper use of the controller and the brake, and where the old rheostat method of control is used the opportunity for waste on the part of the motorman is yet greater. Almost every street railway superintendent, moreover, makes a different estimate of the percentage of power wasted upon the system under his charge, for there can be no positive knowledge upon the subject nor can the conditions be regarded as at all stable. An average drawn from the opinions which have been expressed to me, would, however, indicate that no less than 20 per cent of the total energy generated is wasted by improper manipulation of the handles upon the part of the motorman. This improper manipulation being due, to some extent, to ignorance, but more generally to carelessness."

The practice which was long since adopted by many steam roads of offering prizes to the engine crew doing the most work with the least coal and water, could well be patterned after by street railway companies, which will find the adoption of meters on electric cars to afford a reliable means of checking the carelessness of motormen and of reducing the amount of the coal and water bill. This means either a saving of say 10 per cent in the operating expenses or the ability to operate 10 per cent more cars with the same central station capacity.

"Them electrical fellers is goin' ter make us work fer 'em," bubbled the Water Fall to the Brook.

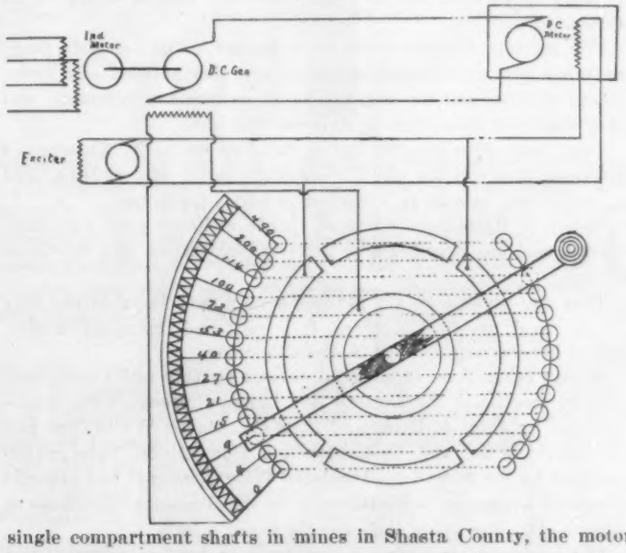
"Well, I'll be dammed!" babbled the Brook.

—Electrical Review, N. Y.

Mining

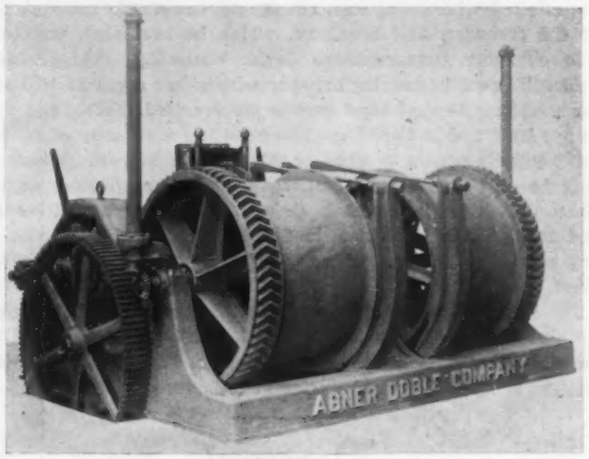
A SUCCESSFUL TWO DRUM ELECTRIC HOIST.

Various expedients have been resorted to in California for the operation of mining hoists by electric power derived from polyphase circuits. Induction motors are in satisfactory use in two

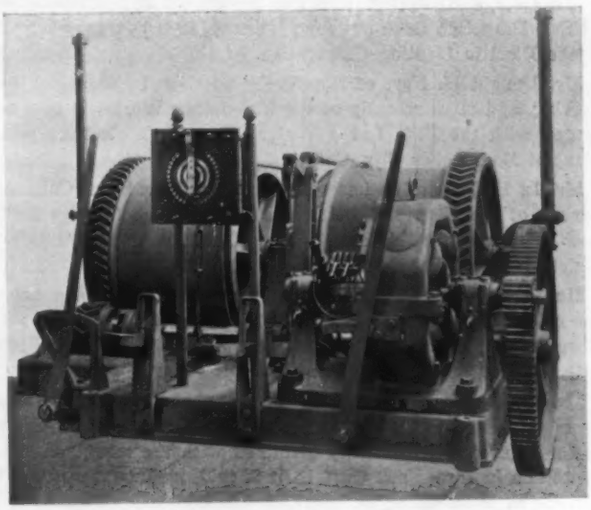


single compartment shafts in mines in Shasta County, the motor being geared direct through an engaging clutch to a winding drum in ascending, and lowering being accomplished by an ordinary band brake. Shafts containing two or more compartments, however, present difficulties not found in single compartment shafts, particularly for the reason that it is desirable to use a single motor for the operation of all compartments, for the reason that the skips can be balanced one by the other. The two compartment hoist in the Gottschalk mine, which is one of the Calaveras properties of the California Exploration Company, is operated by a combination two-phase and direct current system embodying new features not heretofore seen on the Pacific Coast.

A twenty horse-power General Electric two-phase induction motor is direct connected to a 15-kilowatt, direct current mul-



tipolar generator, having 125-volt fields and a 500-volt armature and from the shaft of which is belted a one-kilowatt 125-volt shunt wound, bi-polar exciter. The equipment thus far described, together with the necessary step-down transformers, is placed in a small sub-station at the entrance of the mine tunnel, and within the mine is a 20- horse-power, multipolar, direct current motor, having fields and armature corresponding to those of the generator, and which is geared through a double reduction to a two-drum hoist as shown in the accompanying illustrations. Conveniently located on the hoist is a controlling field regulator



by means of which, as will be detailed, perfect control of the skips is had.

The circuit connections of the equipment appear in the accompanying outline diagram, in which the field regulator is shown in exaggerated size that its construction may be more fully understood. From this diagram it is clear that the shunt wound exciter maintains a constant excitation of the fields of the motor and that from it is also derived current for the excitation of the fields of the direct current generator, such current being of either

polarity as required and of a wide range of amperage due to the introduction of a graduated resistence into the exciting current. The value of this resistance in ohms is expressed on the diagram.

Inasmuch as the fields of the motor are under constant excitation at a fixed polarity and as the armature of the generator is permanently connected with that of the hoist, and as, moreover, the generator is normally running with no field, it is evident that the creation of any field in the generator will be instantly manifested in the armature of the hoisting motor and also that the direction of rotation of the motor armature will depend upon the polarity of excitation of the generator fields. These conditions are effected with the utmost celerity by the simple manipulation of the reversing field regulator, which is, as stated, merely a pole changing and resistance device controlling the generator fields. The motor gearing engages with either drum at will and the usual mechanical band breaks are provided to hold the skip at any level and in lowering. The hoist has a capacity of raising 2,000 pounds net, at a speed of 200 feet per minute. Whatever may be said of the first cost, complication or efficiency of the Gottschalk hoist, it is certain that in matters of ease of control and reliability of operation, it stands pre-eminently superior to any polyphase driven two-drum hoist yet installed in the far West.

The form of hoist equipment described constitutes that known as the H. Ward Leonard system and it was built and installed by the Abner Doble Company, San Francisco, all direct current apparatus being of Crocker-Wheeler manufacture.

Personal

Mr. A. E. Brooke Ridley is now in the East on business and may go on to London before returning.

Mr. J. A. Cranston, of the Portland office of the General Electric Company, has been a welcome visitor in San Francisco recently.

Mr. J. W. Brooks, of the Brooks-Follis Electric Corporation, has returned to San Francisco after a month spent in the various business centers of the East.

Mr. George B. Fraley, who was prominent in electrical circles of San Francisco three or four years ago, is now manager of the Globe Electric Heating Corporation, of Philadelphia.

Mr. Donald H. Fry, of Stanford's '96 class in electrical engineering, and more recently of the Union Iron Works, is now connected with the Blue Lakes Water Company's electric power plant at Blue Lakes City, Cal.

Mr. L. B. Pemberton has relinquished the Southern California agency of the General Electric Company at Los Angeles and is now editing and publishing "Town Talk," a very entertaining society paper of Pasadena, Cal.

Mr. C. E. Dutcher, who bears the reputation of being one of the most thorough constructing electrical engineers of the Pacific Coast, is at present engaged in expert work for the Doris Syndicate, Ltd., of London, Eng., at Candelaria, Nev.

Mr. F. W. Hawley, of New York, one of the electrical engineers associated in the construction of the Niagara Falls electric power plant and prominently identified with the recent electrical exposition in New York City, is, it is said, under engagement by Mr. C. P. Huntington to report on the cost and advisability of equipping the local steam lines now connecting with the ferry system at Oakland Mole, with electric traction.

Mr. C. S. Young, of San Francisco, well and favorably known in financial and mining circles throughout California and Nevada, and late right-ofway agent for the San Francisco and San Joaquin Valley Railroad, will soon enter the business of promoting and financiering electrical, transmission and similar undertakings. His reputation is of the best and any enterprise he enters will be assured of the strongest financial support.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

NEW AGENCIES FOR THE COAST.

Mr. John W. Brooks, who has just returned from an extensive trip throughout the East, in the interest of the Brooks-Follis Electric Corporation, of which he is the manager, has brought out a number of new lines of material that will be interesting to all in the electrical business.

Their contract with the Interior Conduit & Insulation Company, of New York, manufacturers of the well- known Lundell Fan and Power Motors, has been renewed. In this connection, it will be well to state that the Interior Conduit & Insulation Company have consolidated with the Sprague Electric Company, manufacturers of electric elevators, and are going to build machines direct connected and belted up to 150 kilowatt.

The Brooks-Follis Electric Corporation will carry machines in stock as high as 50 horse-power, so will be in an enviable position to fill orders for machinery of this kind with promptness and dispatch. The price on Lundell Fan Motors has been reduced for the coming year, and they anticipate a large business in this line.

They also concluded arrangements with the Herzog Teleseme Company to handle their well-known line of signal apparatus for hotels and elevators. The Herzog Teleseme Company is manufacturing a small annunciator of 10 drops capacity, which does not occupy more than 3x7 inches. This is quite a novelty in its line, as it is the first annunciator that is impossible to get out of order. They will make them for all sizes, and the price is extremely low.

Another novelty that they have brought out from the East is Electric Signs that can be used both in the day and night time. This sign is made up similar to all signs for day use, and has raised gold letters on it, thus making it a show sign for day use. It has small holes distributed throughout each letter, which are filled in with opalescent glasses. Incandescent lamps are arranged so as to give a proper distribution of light, thus making it a perfect electric sign, and by far the best thing yet on the market. One special point of advantage in this sign is the economy, as it only requires one-fifth of the number of incandescent lamps required to operate the ordinary electric sign, and furthermore, it can be used both day and night. It is fully covered by patents, and they have absolute control of the entire Coast.

The Anchor Electric Company's specialties of sockets, snap switches and push button switches are also handled by them. These switches are too well-known to require any comment, and they expect to do a large business in this line.

They have also brought out a full line of A. T. Thompson's electrical material for electric photographing, stereoptican and optical work, as well as a full line of slides for same.

Fisher & Cramphorn's line of knife switches are also well-known, and the Brooks-Follis Electric Corporation has the Coast agency.

They are putting on the market a very neat thing in the way of electrical medical battery. It is neat and compact in size, and is handsomely finished in Spanish cedar.

Among other lines of material carried by this well-known firm may be mentioned the Duncan Arc Lamp, Crescent Wire, manufactured by John A. Roeblings' Sons Co., Raven White Core and Grimshaw Wire, and Grimshaw and Competition Tape manufactured by the New York Insulated Wire Company, and also the telephone apparatus manufactured by the Standard Telephone & Electric Co., for whom they are the Coast agents.

The telephone apparatus is meeting with marked approval and over 9,000 of these instruments are in use in the State of California alone. In the city of San Jose there is an installation of

800 telephones, and only one man is required to chase trouble on the line. It would pay anybody to communicate with them who contemplates the installation of a central station or of small intercommunicating sets. A full stock of this material is carried in San Francisco.

While East, Mr. Brooks made arrangements to place the Eastern agency for the Duncan Arc Lamp.

The lamp is extraordinary in its line, requiring only 2¼ amperes of current burning at 100 volts to operate the lamp, on either direct or alternating current, and it gives 750 candle power. It burns 100 hours without retrimming, and while it is economical in the cost of current consumption, it is economical in the cost of carbon consumption, as it requires only $1.08 worth of carbons per year per lamp.

Mr. Brooks reports trade in the East as being very brisk, and say the outlook for next year is very good.

IMPERIAL PORCELAIN INSULATORS.

C. S. Knowles, of 7 Arch street, Boston, and who is general agent for the Imperial Porcelain Works, of Trenton, N. J., has issued an attractive little booklet which embodies much that was

contained in the paper read by Mr. H. D. Sears before the Santa Cruz Convention of the Pacific Coast Electric Transmission Association (see Vol. IV, No. 6, page 117) and which also describes the special features of merit of the Imperial High Potential Porcelain Insulators, now being used on the Niagara-Buffalo transmission line, and which are to be used on the 33,000-volt circuit of the Southern California Power Company.

The claim is boldly made that the problem of securing a high potential insulator has been solved in the use of Imperial Porcelain, in support of which the assertion is made that wherever high potential insulators have proven satisfactory they have been made of Imperial Porcelain. Wherever they have given trouble they have been of other makes.

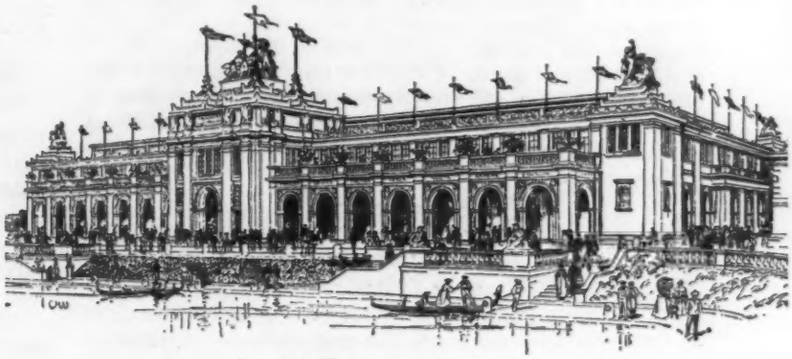
In support of this statement, the "Electrical Engineer" of December 23, 1896, is quoted, which states that: "Reports from Niagara go to show that the power tranmission to Buffalo is working very successfully. The trouble with the insulators has been eliminated since the exclusive use on the line of the 'Niagara' insulators made by the Imperial Porcelain Works."

There is also added a letter from Paul M. Lincoln, electrical superintendent of the Niagara Falls Power Company, dated January 21, last, in which he says: "The insulators which you have sent us and which have passed our test are satisfactory in every respect. We have yet to have our first trouble with them on the line. This applies to the 'Imperial' type as well as to the larger sized insulators which we are using, although the 'Imperial' type insulators were put up for only temporary use. The quality of the porcelain is much better than any other that has come under my observation. It is thoroughly vitrified and homogeneous throughout."

Continuing, the circular states: As our smallest insulators will stand the puncture test as well as the largest, the style to be used in any case is decided by the surface distance and the direct distance between tie wire and pin. The greater these distances the less liability there is to surface leakage and to the current jumping through the air. The higher the voltage used the larger, of course, should the insulators be. It is rather difficult to give the exact voltages to which our different types are adapted, as the climatic conditions have to be carefully considered. The following, however, we consider safe under all except extremely unfavorable conditions:

Imperial Nos. 3 and 4 for 5,000 volts; Imperial No. 2 for 10,000 volts; Imperial No. 1 for 15,000 volts; Redlands, type C and Niagara for higher voltages. In most cases, however, we should not hesitate to recommend Imperial No. 2 for 15,000 volts and Imperial No. 1 for 20,000 volts."

All types of Imperial insulators are "triple petticoat," and all, except "Niagara," are circular in shape. We would call special attention to this type; it is oval in shape and has a gutter on each side for the purpose of draining water clear of the cross-arm. Imperial No. 3 is made with a large top groove and was



THE ELECTRICITY BUILDING.

designed specially for carrying electric railway feeder cables. In vertical cross section all types are of the same general design.

Messrs. John A. Roebling's Sons Co., 25-27 Fremont street, San Francisco, are Pacific Coast agents for Imperial Porcelain Insulators.

ELECTRICITY AT THE TRANS-MISSISSIPPI EXPOSITION.

Electricty will play a very prominent part in the Trans-Mississippi and International Exposition, to be held in Omaha, Neb., from June to November, 1898, as is evident from the plans and preparations that are being made for the erection of the machinery and electricity building. This structure is located in the northeast corner of the Grand Court, being east of the Mines building and across the lagoon from the Manufacturers building. The design is goverened by the general conditions requiring harmony with the other buildings; the architecture of the group is modern Renaissance.

The building is 304 feet front by 144 feet in depth. There are triple entrances on the main floor level in the center of the main front, and similar groups in the centers of the east and west

fronts, with four emergency exits in the north wall. In front of the building, flanking both sides of the main entrance, is an open portico sixteen feet wide, running the entire front of the building. The center entrance feature projects beyond the portico, thus forming the grand entrance vestibule. The main floor covers the entire area of the building. Above is a gallery thirty-two feet in width, extending around the four outer walls. The gallery is reached by spacious staircases located in the front corners of the building. In the rear corners are commodious toilet rooms. This leaves a high central court 248 feet long by 80 feet wide, lighted from the sky-lights and clere-story windows above the roof.

The character of the exhibits sheltered by this building is shown by the decoration. The ornamental spandrels and panels receive all of their motifs and suggestions from machinery. The cresting at the top is composed of cogwheels, this principle being carried out in all of the decorations. The underlying principle and function of machinery is symbolized by the groups of statuary on the top of the building. At each of the four corners are groups representing the early supremacy of man over the untamed forces of nature. These forces are represented by wild animals. Men in their youth are seen subduing them for the simple purpose of escaping injury and the preservation of their own lives at the sacrifice of the natural forces. A higher supremacy is shown by the center group, which is the dominating feature of the entire design. In this, man developed beyond the youthful stage, having wisdom, takes these same untamed, unharnessed forces of nature and harnesses them to his chariot, making them do his bidding, symbolizing in a direct way the service which machinery does for man in using the powers of steam, fire, electricity and graviey.

Color enters into the design with maximum importance. The ornaments in the panels under the porticos and over the main entrances will be highly emphasized by small background spaces of strong colors. These are treated in such a way as to give great interest to the spectator near by without detracting from the general quiet and dignity of the view from a distance. The entire building will be a series of yellow and ivory tones, growing more intense as they reach the top, culminating in the dull golden statuary full of primitive vigor which surmounts the building and symbolizes its use.

BUILDERS OF THE BLUE LAKES PLANT.

Whenever an enterprise of magnitude is completed and put in operation, the engineering public becomes at once desirous of learning who were the builders of the enterprise or, in other words, to whose care was intrusted the furnishing of the labor, materials, and apparatus that constitute the vital portions of the plant. The answer to this enquiry, if relative to the electric transmission plant of the Blue Lakes Water Company, will now be given.

The copper for both the transmission circuits from the plant was furnished by the San Francisco branch of the John A. Roebling's Sons Company, and the wire is supported on Locke's triple petticoat China insulators, furnished by John Martin, Pacific Coast agent for Fred M. Locke, of Victor, N. Y.

The redwood poles of both the Amador and Calaveras circuits were supplied by the Union Lumber Company, of 106 California street, San Francisco, who make a specialty of selected redwood poles in all sizes and lots.

The entire electrical equipment, including generators, switchboard and transformers, was furnished by John Martin, of 300 California street, San Francisco, Pacific Coast agent for the Stanley Electric Maunfacturing Company of Pittsfield, Mass.

The electrical installation was placed under the direction of Theodore E. Theberath, electrical engineer for Mr. Martin.

The Abner Doble Company designed, built and installed the Doble water wheels used in the plant and also furnished the exciters, the steel "Y" castings and slip joint steel pipe used in the upper portion of the pipe line.

The lap-welded steel pipe used in the lower portion of the pipe line was made by the National Tube Works and furnished by the Dunham, Carrigan & Hayden Company, Pacific Coast agents, while the rivited steel pipe was furnished by W. W. Montague & Co., San Francisco.

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